POWER

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Action Toward Governmental Regulation of the Coal Business

PRESIDENT COOLIDGE has asked Congress for power to deal with the coal question.

Governor Pinchot has called the legislature of Pennsylvania to its first extra session in twenty years with a recommendation that it consider means of regulating "through an appropriate state agency any and all of the businesses of producing, preparing, selling and distributing anthracite coal for domestic use in Pennsylvania" and legislation to authorize compacts with other anthracite-using states and the District of Columbia for regulating the business in these states "through an interstate commerce commission or otherwise."

The United States Coal Commission, in a report issued two years ago, declared the mining and distribution of coal to be charged with public interest and advised legislation to protect this interest.

Are we really likely to get some action in that direction?

Eventually, of course, the day will come when it will be considered just as unthinkable that a handful of owners should dictate the terms upon which this basic national resource shall be mined and sold as that the owners of the railroads should operate them to their own notion and profit and not in the public interest.

And quite as unthinkable that a group of workers should acquire the monopoly of the right to work the mines and exercise it when and as they pleased.

Historians will wonder some day how the docile public put up with it so long.

If coal is made a public utility, there will still be the question of "enforced servitude." Can men be made to work against their will even on a public utility?

Or may we see the day when a concentrated attack upon a service necessary to the public welfare is considered a conspiracy?

If coal is made a public utility, we may be able to organize it on a basis fair to owners, operators, miners and the public in the light of real knowledge of the costs involved and profits collected.

F. R. Low

Year's Progress in Power Field Shows Many Marked Advances

IN THE review of a year ago improved business conditions were predicted for 1925. In looking back over the last twelve months it is evident that this forecast has materialized, particularly in the large machinery business of the power-plant field. For the smaller products there has been increased demand from which certain manufacturers have profited more than others. Underlying reasons for the better business in the field have been the numerous unit additions to many of the large central stations erected within the last few years, a limited number of new stations and demands from the industrial plant greater than in any one year since the world war. Indications are that this good, steady business will continue in 1926 and in certain lines improve with reasonable profits to those giving the greatest attention to economy and cost reduction. Reports coming in from the power plant show remarkable improvement in fuel economy in many of the large stations pioneering in the new developments, such as high pressures, stage bleeding, air preheating, reheating between stages, etc. Each of these items has contributed to the gain to give an aggregate approximating 25 per cent over the results obtained approximately two years ago.

RESULTS obtained from large new steam plants pioneering in the many recent innovations in equipment and station design show remarkable reduction in fuel consumption. A condensing steam station has operated on a heat rate of 13,715 B.t.u. per kilowatt-hour. Tests on hydro-electric units have shown combined over-all efficiencies of 92 per cent for the turbine and generator. Researches in metals and refractories have shown progress that again opens the question of high temperatures versus high pressures. Improvements in furnace designs give promise of higher boiler ratings, with a reduction in combustion space and increased use of water walls. To lower the production costs, reduction of fixed charges is now one of the leading problems. Both steam and hydraulic units are being planned for unprecedented capacities.

Reverting back to 1913, the most efficient central-station plants in the country were producing a kilowatt-hour on 22,500 B.t.u. Up to 1916 there was gradual improvement down to 20,000 B.t.u. per unit, and for the next seven years during and following the war, new construction and development in general was practically at a standstill, for in 1923 the heat consumption of the best stations in three countries, England, France and the United States, ranged from 18,000 to 22,000 B.t.u. per kilowatt-hour. Then came the great avalanche of new power stations to make up for the seven-year recess, with the many innovations that have been responsible for giving results as low as 13,715 B.t.u. per kilowatt-hour. A point has been reached where further gains with present methods will be difficult until superheaters, piping and materials in general are available for higher temperatures or until the mercury vapor-steam binary system is perfected for commercial application.

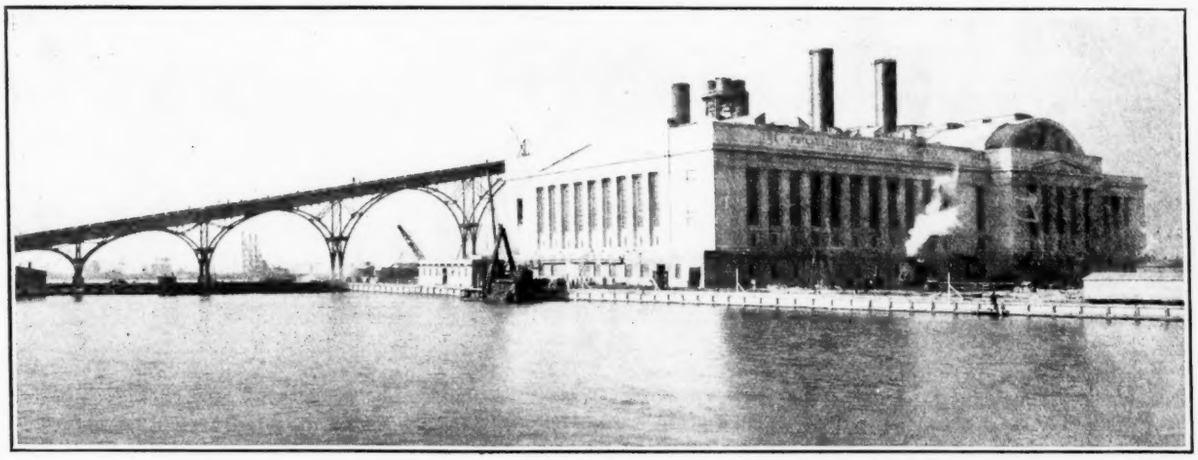
How this improvement in economy over a twelve-year period has affected the four major items entering into the cost of electrical production in large stations (labor, maintenance, fuel costs and fixed charges on investment) has been portrayed in these columns, and originally in a paper before The American Institute of Electrical Engineers. In 1913 the total cost per kilowatt-hour of net station sendout was five mills, consisting of two mills each for fixed charges and fuel costs and one-half mill each for operating labor and maintenance. During the entire period to date these last two items have remained practically constant, concentration into larger units having reduced the attendance so as to offset the higher wage. Interest, therefore, centers in the fixed charges and the fuel costs. From 1913 to 1920 these two items more than doubled as a result of the rise in the cost of equipment and materials and the higher prices of fuel. The average for each was close to 4¼ mills, and for the next three years they varied slightly one way or the other, the average of the two for the period being 9½ mills.

From 1923 to date this total dropped to eight mills, not from any change in fixed charges, maintenance or operating labor, but almost entirely from the reduction in fuel cost per kilowatt-hour, which fell from 4¼ mills in 1923 to 2½ mills in 1925. Results of such magnitude reflect great credit on the diversity of engineering talent involved.

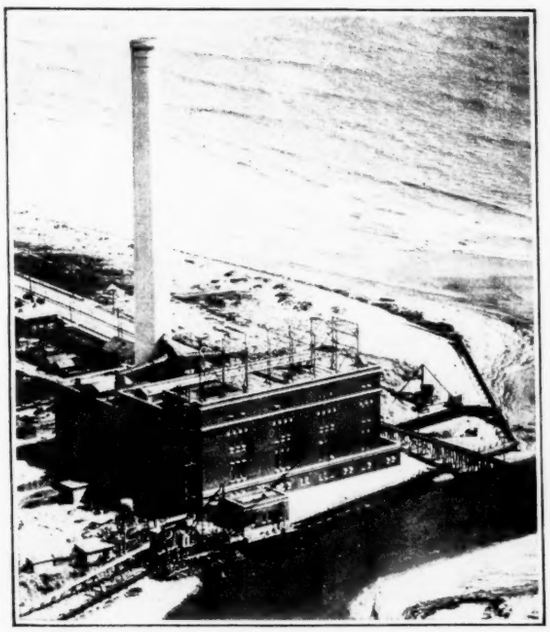
Economy in fuel was the first essential obtained by concentration on this one item. It will always remain a leading factor, but in the immediate future the greatest opportunity for saving in these large stations—60,000 kw. and over—lies in the reduction of fixed charges.

At Weymouth the first 1,200-lb. steam boiler and turbine introduced into American practice went into operation during the year, and plans are under way for a similar installation, differing in certain details, for Milwaukee.

Of the new stations now under way perhaps the most



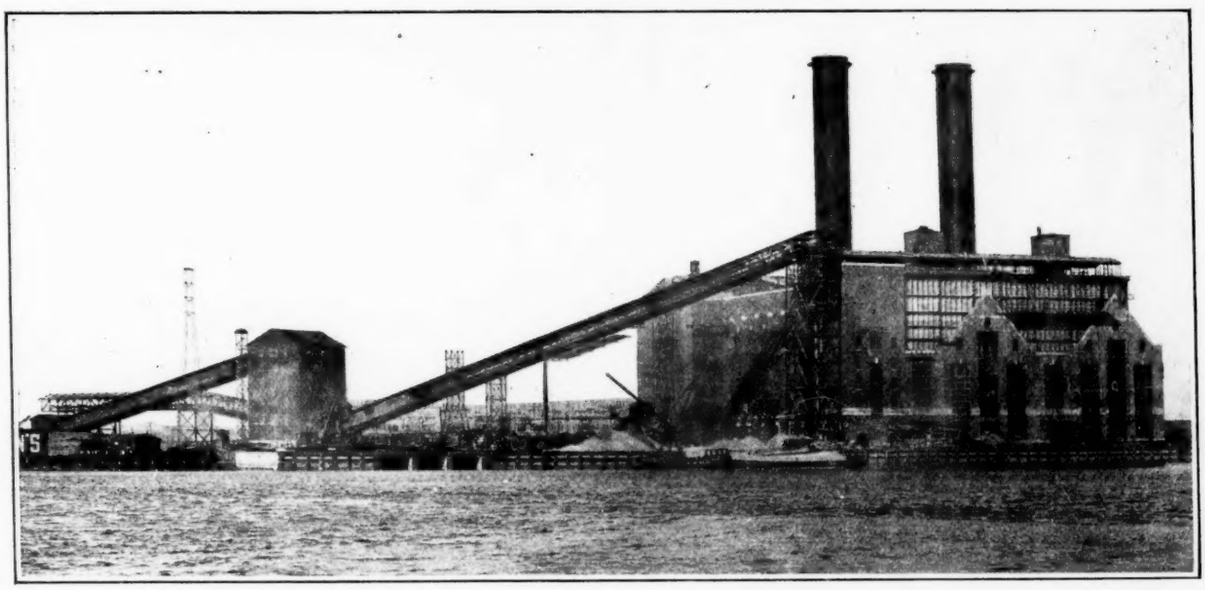
Three Important Steam-Electric Stations put into Operation During 1925



Above — Richmond station of Philadelphia Electric Company. Plant is stoker fired

Left — Seal Beach station of the Los Angeles Gas and Electric Corporation. Burns oil and natural gas

Below — Kearny (N. J.) station of the Public Service Power Company. Plant is stoker fired.



notable is that of the New York Edison Company, in which it is proposed to install nine machines 60,000-kw. or larger. Another station embodying some unusual features is now under construction near Scranton, Pa., in which 700 lb. pressure will be employed. There will be a single boiler room flanked on either side by a turbine room.

In size of units, there has been some advance, with due consideration to the relative proportion of unit to station capacity and the amount of capital lying idle with one of these enormous machines shut down. Naturally, their use is limited to large base-load plants, such as the Crawford Avenue Station in Chicago, which has on order a machine of 77,000 kw. capacity and the Hudson Avenue Station of the Brooklyn Edison Company, where an 80,000-kw. cross-compound turbo-generator is to be installed in the summer of 1926. These capacities may be compared to the three 65,000-kva. hydro-electric generating units at Niagara Falls, the largest ever constructed. Information is at hand upon good authority that tentative plans are being considered for 150,000-kva. steam turbo-generators for use in a new station in the Middle West.

Superpower has been rechristened and now has the more appropriate title "interconnection," as this expresses exactly what was intended in this great movement of linking plants and systems together and to the layman gives a better conception of what is taking place. The advantages of interconnection to the producer of electrical energy and the consumer as well, have been established, and the activity in this direction has been phenomenal. Almost daily the press continues to announce new consolidations and future power-development programs, and this applies quite generally to all sections of the country.

Large industrial plants have taken advantage of the development work by the central stations in the power field, which has rendered high-pressure boilers and other improved equipment available as more or less standard products. This is evidenced by a marked activity among the larger industrial plants toward the use of higher steam pressures, with the employment of high-pressure turbines exhausting at a high back pressure for process steam. There has been considerable activity in this line among plants serving the rubber industries and chemical works.

Similarly, a number of industrial establishments, already having low-pressure plants but needing increased capacity, are installing high-pressure boilers with turbines exhausting into their present steam mains, thus securing the benefit of greatly increased economy without the necessity of replacing the old plants.

While the steam turbine is being used in the majority of cases for this high pressure work, there are nevertheless cases where the steam engine is being employed. One of the chemical industries has recently installed a cross-compound steam engine operating on 350 lb. pressure and 250 deg. superheat, with poppet valves on the high-pressure side and Corliss valves on the low-pressure. Bleeder heating is also being introduced into the more modern industrial plants, and many either have installed or are considering pulverized coal.

Boilers and Boiler Auxiliaries

Air Preheating and Water-Cooled Walls Prominent in Furnace Design—Improved Metals Give Preference to High Temperatures Over High Pressures—Present Limitations and Status of the Various Auxiliaries

DURING the last three years the power plant, and in particular the department of steam generation, has been in a state of rapid evolution. More has been accomplished to increase thermal efficiency than in any other period of like duration since the days of James Watt. This has not come from any one factor, but represents the aggregate gain from the use of higher steam pressures and temperatures, preheated air, water-cooled furnace walls, stage bleeding, improved furnaces and firing methods, increased absorption of radiant heat, reheating between stages, alternators driven by the main units to supply auxiliary power and other items of less import.

Combustion Air Preheating

Intensive studies of the functioning of the new equipment, abetted by interchange of practical experience, have disclosed that the original conceptions were fundamentally sound and that results in certain cases even were beyond theoretical estimates. This has been true in the case of preheated air, where the gain by the recovery of waste heat from the flue gases and the higher temperature levels in the furnace is enhanced by better combustion. The development of air preheaters has been rapid and the use of this device is showing interesting results. Experience with the preheater has been varied according to the kind and the character of the fuel used and the amount of tarry deposit, but apparently no insurmountable difficulties have been encountered. In the future, air temperatures of 500 to 600 deg. F. are commonly predicted, and in favorable cases there is intimation that air temperatures of 800 deg. may be practical. Another point that should be observed is that the application of the preheater will not be limited to the large efficient plant, for the poorer the performance of the combustion equipment when supplied with air at ordinary temperatures, the greater the gain from preheating.

Cooling of Furnace Walls

The use of water-cooled walls has met with considerable success during the last year, and a number of furnaces so equipped are now in operation. Although the amount of water-cooled surface that can be installed without affecting combustion is still the subject of debate, it has been found to depend to a large extent upon the kind of coal used and the fusing temperature of the ash. It is generally deemed necessary to have enough refractory surface to reflect sufficient heat to keep the temperature of the gas of the entire furnace above that required for combustion. In this connection particular attention attaches to the new type of boiler designed by

B. W. Burroughs, of Montreal, Canada, in which the furnace is formed entirely by the boiler tubes. This will permit taking full advantage of flame radiation. In this particular unit one burner only is used; this enters the furnace through the center of the upper vertical drum of the boiler.

Similar in some respects to the boiler just mentioned is the new Wood boiler. The furnace section of this boiler is square in form with complete water walls and is fired with four burners, one being placed in each of the four corners and directed to give a turbulent action within the furnace.

Water-cooled and sectionally supported air-cooled furnace walls have made it possible to preheat the incoming

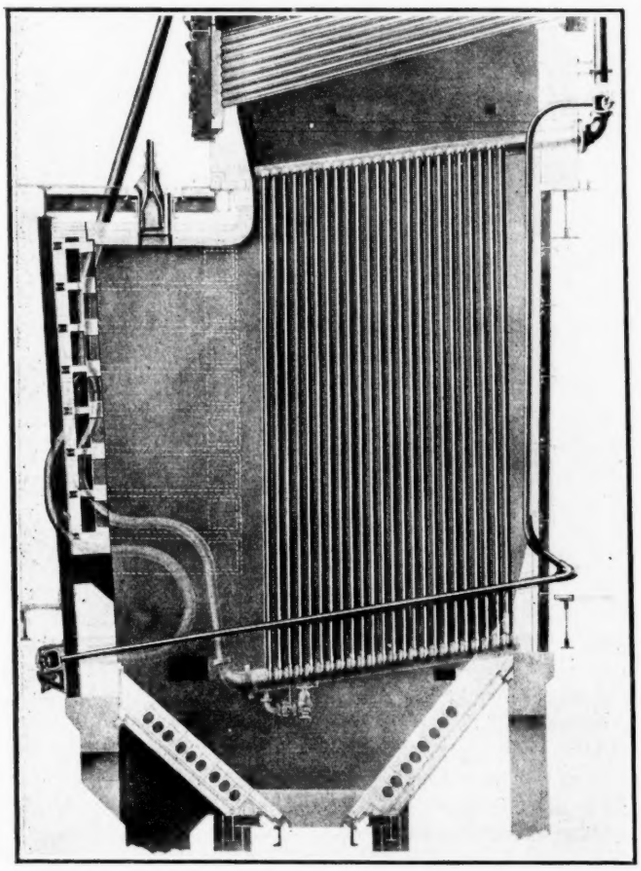


Fig. 1—Improved fin-type water wall as applied to powdered-fuel furnace

combustion air to these temperatures. Numerous installations of water-cooling surface of varied types have been made, and the results have been so favorable that water cooling has now become a recognized method of furnace protection that will permit the intensive operation desired from steam-generating equipment.

Enthusiastic predictions have been made that boiler ratings in the future will range from 1,000 to 2,000 per cent and that the steam-making surface in boilers will be reduced from the present average of one to two square feet per kilowatt of station capacity to one-quarter square foot, with only a small number of rows of tubes in the boiler proper. These predictions are based on the use of pulverized fuel, water-cooled furnace walls and air heaters to reclaim the greater waste in the flue gases and furnish highly preheated air for combustion. The River Station extension of the Buffalo General Electric Company with "well furnace" pulverized-coal firing, is now under construction on the basis of about three-quarters square foot of boiler-heating surface per kilowatt of station capacity and the boilers will contain but nine rows of tubes.

The use of water-cooled walls has precipitated considerable discussion as to the probable effect on furnace temperatures and the over-all economy. Experience has shown that it is important to transfer as much heat as possible by radiation, as the rate of absorption by radiant heat is eight to ten times that by convection. Certain data available indicate that the furnace radiation to metal side walls may be as high as 75,000 B.t.u. per square foot per hour, and much valuable work has been done both theoretically and practically to ascertain specific values of radiant heat absorption under varying conditions of heat release and other factors. It appears that carbon dioxide and water vapor have the property of both absorbing and emitting radiant heat.

B. N. Broido has referred to the tendency to overlook this radiant effect of the gases themselves. The ability of CO_2 and water vapor to absorb and radiate heat should have an influence on furnace and boiler design. As this radiation is most effective at high temperatures and low gas velocities, large furnaces are important to insure these low velocities and the maximum absorption of radiant heat. In his opinion the boiler of the future will consist of a large furnace with the maximum amount of radiant-heat absorbing surface and some refractory where the coal is high in moisture and ash. Much of the steam will be generated in the surface lining the furnace, and the gases will be cooled to a temperature at which no more heat will be absorbed by radiation than by convection.

Economical Limits of Steam Pressure

One of the considerations of the brief digestive period that has been going on, is the question of pressures and the economical limit to which they may be carried. Results from plants now in service using pressures of 550 to 600 lb. and temperatures to 750 deg. have been favorable, and notwithstanding the added complication and the use of equipment other than standard, the initial cost has been increased by a comparatively small amount, owing to the greater density of the steam and the reduction in size of equipment. Above the present limit of about 400 lb. for boilers of present-day standard design the advantages of increased pressure decrease rapidly unless combined with the reheating of the steam at some point during expansion.

The mechanical operation and economies obtained have proved equal to expectations. The first 40,000-kw. unit in the Philo Station of the Ohio River Power Company went into commercial operation late in 1924, and the second machine has since been put in service. These units have operated both with and without reheat, and during the time they have been in service no difficulties of any kind attributable to high pressure or high temperature have developed. The operation of these machines has demonstrated a point that was not generally anticipated, that is, the station economy with 550 to 600 lb. and reheat is practically constant for wide variations in load. Two similar machines installed in the Twin Branch Station of the American Gas & Electric Company have also been placed in successful commercial service. One of the 60,000-kw. cross-compound units installed in the Crawford Avenue Station of the

Commonwealth Edison Company was placed in commercial service in November, 1924. The unit was operated without reheat until the other two units in this station were ready for commercial service. Since May 23, 1925, this unit has operated with reheat with entire satisfaction. No change in the operation was required when the reheat boiler was placed in service, and it was not necessary to make adjustments of any kind to the turbine, and the reheat may be put on and taken off without any difficulty whatever. The new Columbia Station at Cincinnati, recently placed in service, also employs reheating.

At the Edgar Station of the Edison Electric Illuminating Company of Boston, at Weymouth, Mass., two pressures are utilized, the main portion operating at 375 lb. In addition to this, there are installed a boiler and a turbine operating at 1,200 lb. pressure. The turbine exhausts at 375 lb. through a reheater located in the setting of the 1,200-lb. boiler into the steam system of the main portion of the plant. The operation of this installation is being closely watched by the industry, as its success will provide a means for the rejuvenation of existing low- and medium-pressure plants by the installation of high-pressure units.

Such pressures with even moderate degrees of superheat naturally involve the question of the ability of metals at present available, at reasonable cost, to withstand the stresses at these high temperatures. From various sources there is indication that satisfactory materials at satisfactory cost will soon be available that will permit steam temperatures being raised from 750 to 1,000 deg. One American manufacturer is already offering a line of valves and fittings for the latter temperatures. In England there is discussion of workable materials that may be used up to 1,300 degrees.

In Czechoslovakia a contract has been executed for a steam plant utilizing temperatures of 842 to 932 deg. F. at 1,400 to 1,700 lb. throttle pressure, for an 18,000-kw. turbine with four cylinders on a single shaft, a speed of 3,000 r.p.m. and no reheating.

Studies on the relative advantages of higher temperatures indicate considerable commercial gain if pressure around 400 lb. could be used with steam temperatures of 800 to 1,000 deg. There would be no need to change boiler design, and the decreased steam consumption would permit reduction in the size and cost of condensers and auxiliaries. While admitting the need of new materials for parts subjected to temperatures above 750 deg., it is pointed out that only a small portion of the plant would be subjected to the maximum temperature, that is, the superheater, steam piping and the high-pressure end of the turbine.

Conclusions reached are that, a plant operating on the Rankine cycle at a pressure of 400 lb. absolute, with steam temperatures of 825 deg. or higher, would be more efficient than a 1,200-lb., 700-deg. plant on this cycle. Using the regenerative cycle a 400-lb., 1,000-deg. plant equals the performance of a 1,200-lb., 700-deg. station, and equivalent performances are obtained from operating conditions of 600 lb., 700 deg. and 400 lb., 850 deg. It is evident that the further development of materials for high steam temperatures is warranted, for it is probable that the use of such materials in a plant of moderate pressure would involve a smaller investment than a high-pressure plant of equal economy, on account of the smaller amount of equipment that must be changed from 400-lb. standards to use the high-temperature steam.

It may be of interest to refer briefly to studies made by Doctors Mellanby and Kerr, of Glasgow. Analyses of the power plant from both theoretical and practical viewpoints have led them to the conclusion that the most economical pressure will be 1,250 lb., with two stages of reheating at 500 and 180 lb. Although adding to the complication and operating costs, it is proposed to bleed steam at eight points to heat the feed water to 545 deg. F. Conclusions were reached that present metals will withstand safely temperatures up to 900 deg. Fahrenheit.

Expected performance with the upper pressure and temperature given, 29 in. of vacuum, 90 per cent boiler and economizer efficiency and with an allowance of 5 per cent for station auxiliaries, figures out about 9,875

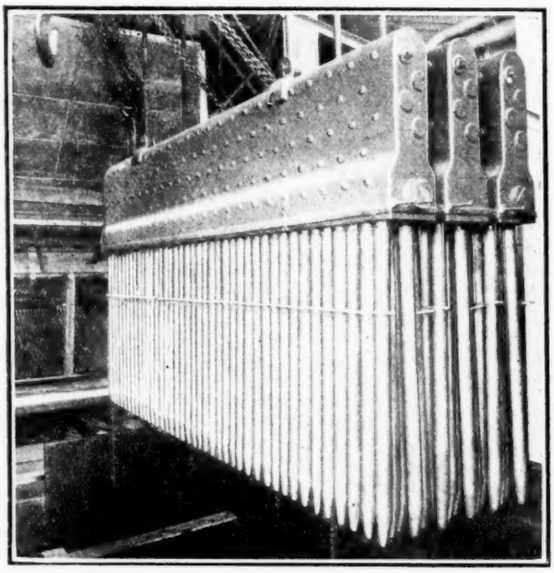


Fig. 2—Three sections of improved mercury boiler

B.t.u. per kw.-hr., requiring 0.73 lb. of 13,800-B.t.u. coal. This corresponds to the remarkable over-all thermal efficiency of 34.5 per cent.

During the year report was made of another Benson plant being installed at Siemenstadt, near Berlin. In this plant are the first straight-tube Benson generator and superheater and two turbines of 1,000-kw. capacity each. As in the experimental plant at Rugby, England, steam is to be generated at the critical temperature and pressure, then superheated and throttled down to about 1,500 lb. for the high-pressure turbine which will exhaust into the low-pressure turbine at 175 lb. absolute.

Something entirely out of the ordinary that has been under way for some time but given publicity recently, is the Brunler internal-combustion boiler developed in Belgium. Air and oil supplied at boiler pressure burn under water and the combustion products pass to the engine with the steam. Remarkable efficiencies are claimed, but require practical demonstration. It develops also that an American internally fired boiler was perfected by James N. Seymour some ten years ago and patented in 1916. While the patent refers only to the burning of gas, it is claimed by the inventor that it is possible and practical to burn pulverized coal under water. Another foreign development that will be of interest is the Weir heat regenerative system designed by C. and J. Weir, of Glasgow.

Previous limits of size for boilers will be exceeded by two units now under construction, each of approx-

imately 40,000 sq.ft. of surface, which are to make up the first section of a central heating plant in Detroit. The increment in heating surface exceeds 7,000 sq.ft. over the previous title holder, also a high-pressure heating boiler in the Cecil plant of the Allegheny County Steam Heating Company, which contained 32,750 sq.ft. of surface.

Mercury Vapor Boiler and Turbine

W. L. R. Emmett's experience with the mercury boiler at Hartford has proved so successful that a new boiler of a different type has been designed and installed. This boiler is built in sections that can be removed for cleaning and inspection. A new form of mercury heater has also been provided, and a three-stage turbine has been installed to replace the original single-stage machine. The new turbine is expected to give approximately 70 per cent efficiency. Designs for units of 9,000-kw. capacity in the mercury turbine and 12,000-kw. in the steam unit are being considered. Under conditions of 70 per cent efficiency for the mercury turbine and 70-lb. gage pressure for the mercury vapor, on base-load conditions, it is estimated that a kilowatt-hour should be delivered to the switchboard on 10,000 B.t.u.

Developments in Superheaters

In superheaters the latest developments have been along lines making them adaptable to high pressures and high temperatures. With the modern boiler the former location between passes is impracticable, as the gases are not hot enough or too varied in temperature to give the desired results. It has been necessary to use inter-deck designs or to place the superheater elements between the lower rows of tubes where they will be subjected to the same conditions as the boiler surface generating most of the steam. As the same amount of steam generated by the boiler passes to the superheater, it is contended that the superheat will be constant if the heat absorbed by both boiler and superheater varies in the same proportion. This, however, does not take care of the variation in velocity of the steam through the superheater tubes with changes in load, so that the drop may be excessive or too little to protect the superheater, depending upon whether cross-sectional areas have been proportioned for minimum or maximum requirements.

To solve this problem an automatic pressure drop control has been perfected, which bypasses part of the steam around the superheater when the quantity flowing, and therefore the drop through the superheater, reaches a predetermined point. Other courses have been the use of radiant superheaters, some of them placed for protection between the water-cooling tubes of the furnace and the installation of radiant and convection combinations, but here no radical changes have been made other than improved methods of supporting and insulating.

New Designs of Economizers

In economizers there are reports of certain new designs, but detailed information is lacking. The old-fashioned cast-iron economizer has been largely superseded by the steel-tube type, which is now showing satisfactory life. Announcement has been recently made by one manufacturing company of a new extended surface economizer. It is made up in sections consisting of lead-coated steel pipes expanded into forged-steel or cast-steel headers. By a patented process individual steel disks are secured to the pipes so tightly as to afford no opportunity for corrosion between pipe and disk.

In practice it has been found difficult to keep free of soot some of the more recent economizers using extended surface. This was particularly true when the water spray or washing method was used, as the moistened soot would cling and bake on the surface, particularly on the gas-outlet side. In certain installations these conditions have led to the exclusive use of steam blowers, operating at pressures up to 100 lb. in the element.

Stage Bleeding for Feed-Water Heating

By the N. E. L. A. Prime-Movers Committee, it has been found that 96 per cent of the larger stations investigated that have gone into operation since 1923, heat the feed water in two or more stages; 53 per cent use three-stage heating, 25 per cent use two stages and 18 per cent use four stages.

Theoretically, bleeding from a greater number of stages would increase the efficiency of the regenerative cycle, but with a heater for each stage, the complication, the greater cost and the added resistance would soon counterbalance the gain, so that for practical reasons the numbers of bled stages has been limited to four, with the greater number using three.

A new development in the form of a Venturi jet type heater has made it possible to eliminate this multiple use of heaters and to bleed from many stages without undue complication, although calling for very high water velocities. The Venturi element or heater is located in the feed-water main, in which the pressure is raised above boiler pressure by the feed pump to overcome the resistance through the device.

Automatic Combustion Control

Increasing interest is also manifested in the application of automatic control systems to stoker firing and pulverized-coal burning. Several such systems have been successfully installed during the year. There is increasing appreciation of the fact that the operation of the fire room is the biggest job in the power plant, requires the most brains and can be made of such nature that the educated man will welcome and desire an opportunity to show results. The day is here when our boiler rooms are operated by brains and not brawn. The Brooklyn Edison Company states that, through the use of automatic control its Hudson Avenue Station is maintaining day-by-day boiler efficiencies within less than 2 per cent of best test efficiencies.

Already plants totaling 3,500,000 sq.ft. of boiler-heating surface are under full automatic combustion control. During the war the contract was let and the control equipment is now being installed for seventy 6,500-sq.ft. boilers in the Kent Avenue Station of the Brooklyn-Manhattan Transit Co. These boilers will be divided into groups of eighteen, each group operated by a master controller. Any or all of the four masters may be controlled in turn by a super-master. This allows putting any desired number of boilers under the control of the super-master.

Drives for Auxiliaries

Auxiliaries in general have been made to conform to the new conditions imposed by the higher pressures. The tendency to drive most of the auxiliaries by motor still prevails, although there are exceptions where small

geared turbines are being used throughout the plant. With electric drive the tendency is to isolate the auxiliaries of each unit, so that a trouble with one set of auxiliaries will not affect those of neighboring units. In certain plants motors only of the alternating-current type are employed, even for stoker drive, but here a new plan of regulation gives control over a wide range equivalent to that of the direct-current machine. An important development is the general introduction of full-voltage starting, which simplifies the starting mechanism and provides for automatic restarting after a shutdown.

Power to the auxiliaries is supplied mostly by the auxiliary alternator on the shaft of the main unit or by a house generator, the former giving main unit economy and separation from trouble on the line. Here again there are exceptions as exemplified in the Trenton Channel plant, where steam-turbine-driven generators supply the auxiliary power and in the Toronto plant of the Ohio River Edison Co., given mention in last year's review. It may be recalled that for each main unit of 33,000-kw. capacity, there is a 1,500-kw. house turbine which supplies power to all major auxiliaries. The house turbine is bled at 196 and 52 lb. and exhausts at 18 lb. By interlacing these bleed points with two on the main unit, together with a third point for the evaporators, the feed temperature is maintained constant automatically at 378 deg. regardless of the load, while the house turbine generates just the power required for the auxiliaries. The plant efficiency is almost equivalent to that obtained when auxiliary power comes from the main generators, and the important point is that the auxiliary service is independent of any outside or main-unit disturbance.

Cleaning Boiler and Condenser Tubes

Before concluding this review mention should be made of a practice gaining in favor, that of using the sand blast for cleaning boiler and condenser surfaces. The cleaning of difficult spots, such as the removal of clinker from the lower rows of boiler tubes and from radiant-heat superheaters has been tried with success, but caution is recommended, as the protracted use of this process might result in extensive tube deterioration. Where the surface is reasonably flat and the blast applied in approximately the same plane as the surface for a limited period, serious erosion is not anticipated. For the removal of soot from fire-tube boilers while in operation, a simple device using steam at 40-lb. pressure to carry the sand, has been perfected recently and is now available. Sand blasting also has been applied to condensers by means of air at high velocity, to eliminate the more difficult scale not removed by the usual cleaning. In the same way cinders have been used instead of sand. With both materials favorable results have been obtained, with negligible erosion.

Fuels and Combustion

Coal, Oil and Other Fuels, Development in the Stoker Field, the Trend in Powdered-Coal Burning and the Status of Low-Temperature Carbonization of Coal with Byproduct Recovery

DESPITE the general depression still existing in the coal fields, the production of bituminous coal during 1925 exceeded that of the previous year, the demands of industry and commerce throughout the country having been great enough to keep a large proportion of the coal industry producing even though profits were smaller. Much of this increase in production has been in non-union territory, the State of West Virginia and the eastern half of Kentucky having been particularly active.

Figures this year up to December 19 give a total production of bituminous coal of 506,293,000 tons, as compared to 465,668,000 tons for a like period in 1924.

Of numerous attempts made to improve conditions in the coal fields mention should be made of the proposed amendment to the Department of Mines bill advocating the establishment of a Bureau of Coal Economics as a part of the Department of Mines, the conservation conference in Michigan and the discussion of huge mergers in bituminous coal properties to effect economies in operation. Of more interest to the consumer are the lower prices that have prevailed. Statistics show that during the first seven months of the year the price of bituminous coal has been lower than it has been at any time since the first half of 1916, and this applies generally to the remainder of the year, although prices showed some advance.

Production of anthracite up to Sept. 1, when all mines shut down, was about normal, having reached by the week of Sept. 5 a total of 61,639,000 tons, as compared to 61,758,000 tons for a like period in 1924. The normal fall production of 1½ to 2 million tons a week of anthracite, of course, has been shut off, but the few industries that still use anthracite for gas-making and for heat-treating processes were well stocked before the strike cut off the supply and have been able to get considerable quantities of the steam sizes of anthracite since then. Others have converted entirely to soft coal and probably will continue to use it.

The return of cheap bituminous coal and exorbitant prices of oil have apparently reversed the trend toward oil burning in the industrial field where coal can give equal service. In the scientific field research into the character and constitution of fuels has continued in Europe as in the United States.

An increasing need is felt for a classification of coal that will apply universally. Different countries have different limits for the several kinds of coal, different methods of analysis and sampling. When one talks of coal on an international basis, there is much confusion because names are interpreted differently in different countries. There has been proposed by C. I. Seyler, of Great Britain, a scheme that seems to approach the desired end in international nomenclature. Promising efforts are now being made by Bureaus of the American and British governments to pave the way for international adoption of the new classification.

There is today a widespread interest in cleaner coal.

Of the methods of obtaining this, the most interesting are the Trent coal-oil amalgam process and the analogous process of flotation, being developed in England. A plant for applying the Trent process to the production of domestic fuel has been erected at Hamilton, Ontario, the amalgam formed being carbonized. This follows plants that have previously been installed in Newark, N. J., and Toledo, Ohio.

From Texas comes a report of a method of treating lignite by which 30 per cent of the original 35 per cent moisture content is extracted and about 5 per cent of heavy fuel oil is added to increase the heat value about 50 per cent. It is claimed that the total cost of the treated lignite at the mine, including the expense of the dehydrating process, is $2.51 a ton, that it stores well and is less friable than the original coal. Prospects seem promising for further installations of the Hood-Odell Lignite Carbonizer developed by the Bureau of Mines, and on which extensive commercial-scale research was conducted by the Canadian Lignite Utilization Board.

A new method of peat utilization has been introduced on the American market by which the peat is cut obliquely from bottom with a dragline steel bucket conveyed to a moisture expeller and thence to a shredder, where it is reduced to the consistency of wet bran. It is then dried by heat and aëration and forced ahead of rams from powdered peat hoppers over the briquetting presses by a system of helicoid conveyors, heated and kneaded by five successive compressions and finally turned out as a dense 2½-in. briquet, said to be smokeless when properly burned, and free from spontaneous combustion in storage. It is claimed that an average analysis of fifteen samples show carbon 33.22, volatile 60.77, sulphur 0.2, and ash 5.81. The evolution of volatile claimed to be principally methane is very slow, resulting in fairly high efficiencies in domestic furnaces with absence of clinker.

Much interest is manifested in this country and in Europe in the reclamation and utilization of fuels with high ash. In Germany the magnetic separator for recovering unburned fuel from ashes has been installed to a considerable extent. In France the carbonization of high-ash coals has been carried out with the special object of increasing the domestic supply of motor fuel. In Germany and in England high-ash fuels have been suitably mixed with a better fuel and burned under boilers.

Crude-Oil Production

Estimate places the world production of petroleum for 1925 at 1,058,000,000 bbl. as compared to 1,013,000,000 bbl. for 1924. This increase of 4½ per cent is attributed to the greater production in the United States, which rose from 713,940,000 bbl. in 1924 to approximately 755,000,000 bbl. in the year just past. For the last three years the average daily yield in this country has been slightly more than two million barrels. For the first four months of the year the field was below this average, but in May flush production from the deeper sands in the Smackover field in Arkansas caused a sudden rise in output to a daily peak approximating 2,230,000 bbl. From this point the production rate dropped off slowly but did not recede to the early level. There has been little variation in the amount of oil in storage.

Of the total estimated oil reserves of the United States, amounting in round numbers to 9 billion barrels, 5 billion barrels may be classified as oil in sight and 4 billion barrels as prospective and possible. Rather more than 4 billion barrels should be assigned to the heavy-oil group. These oils will be recovered mainly in the Pacific Coast, Rocky Mountain and Gulf States. The contents of the Lima-Indiana region, which yields oil of a distinctive type, are estimated at 40 million barrels. In general the so-called paraffin oils of moderate and high-grade, as contrasted with the heavier oils, amount in all to about 5 billion barrels. The estimated reserves of high-grade oils of the Appalachian States are about 725 million barrels.

The Oil Conservation Board

As with coal the government has been taking an active interest in the oil industry, as evidenced by the appointment of a Federal Oil Conservation Board to work in harmony with producers in studying ways and means of solving the problem of overproduction, excessive costs and wastes prevalent in the field. The creation of this Board has focused the attention of the public on the question of future reserves of petroleum in this country. Notwithstanding the fact that the plan for united action to eliminate waste had its inception in the industry, a storm of opposition soon came from the self-same quarter. Denial was made of overproduction of oil or waste in its recovery, and it was quite apparent that publicity was not desired on facts to which the public is entitled and which might tend to clarify the situation. The Board is continuing to function, but owing to the conditions existing has been handicapped in rendering the service anticipated.

Shale-oil research is continuing under the auspices of the Bureau of Mines looking particularly toward the utilization of the richer shales of Colorado and the eventual commercial utilization of leaner shales when decreasing domestic oil supplies produce a favorable market. In England since 1919 the value of products from a ton of shale has fallen from 255 to about 105 to the extent that on August 28 Scottish Oils, Ltd., decided to close down a considerable section of the industry and reduce wages in the remainder. Bureau of Mines Bulletin 210, issued during the year, summarizes the history, economic and technical problems involved in the production and refining of shale oil.

In fuels research the study of gaseous reactions and synthesis of liquid fuels from gases has undoubtedly been uppermost in the minds of workers in this field. It is generally felt that the trend of future development in motor-fuel synthesis lies in the study of gas reactions. A number of interesting developments have been reported during the year.

Carbonization of Coal

The most promising alternative for synthesis in the solution of future oil problems, which seems more immediately applicable, lies in the carbonization of coal at either high or low temperatures, or in its complete gasification. High-temperature carbonization, already rather thoroughly developed through years of experience, offers little of the new and novel in technique.

In the field of low-temperature carbonization several new processes have been announced during the year, though definite costs and operating data have been scarce, owing to the shortness of time existing commercial scale installations have been in operation. Interest, particularly on the part of power-plant oper-

ators, continues active in this field, and definite progress has been made. Among those who have studied the question there is a sharp division of opinion from a commercial viewpoint as to the merits of low-temperature distillation in connection with power generation.

Meanwhile the work is progressing and already a certain modicum of success has been achieved. Mechanical and thermal difficulties are being overcome, so it would appear that commercial success or failure hinges on the relative prices of coal and of the byproducts recovered. A most excellent non-partisan review of the general situation in Europe, where the majority of the commercial-scale research work on low-temperature carbonization has been done, has been presented by Dr. A. C. Fieldner, of the United States Bureau of Mines, in the report of the subcommittee on Foreign Developments of the Prime Movers Committee of the National Electric Light Association, dated July, 1925. Also by H. W. Brooks in *Power*, Oct. 27 and Nov. 3, 1925.

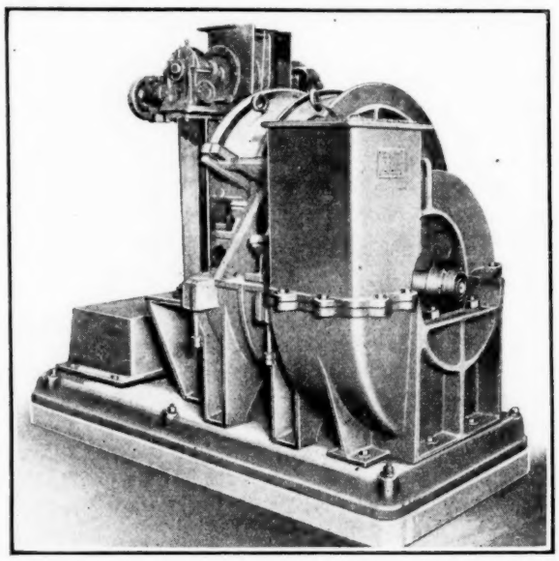
Undoubtedly, the biggest thing of the year in America in low-temperature carbonization is the announcement of the installation of a 200-ton McEwan-Rungue commercial-scale experimental retort at the plant of the Milwaukee Electric Railway, Power & Light Company. It represents a new idea of processing coal in pulverized form before it goes to the power plant, and its success will hence be watched with huge interest by power-plant operators. The second of the two large operating scale installations at the Ford Plant of the Piron process went into operation the latter part of 1925, and encouraging results are reported. The Old Ben Coal Corporation at Waukegon, Ill., is reported to be making a good domestic fuel by low-temperature methods. The McIntire process at the Consolidation Coal Products Company plant at Fairmont, W. Va., is undoubtedly successful in solving the problem of stirring a strongly coking coal. This retort has now been running nearly two years quite successfully. Apparently, the low-temperature carbonization of Pennsylvania and West Virginia coking coals has been solved by this process from a technical point of view, but the material produced is granular and must be briquetted and recarbonized before it can be sold as a domestic fuel. The cost of such operation is such as to make the semi-coke briquet price somewhere in the neighborhood of anthracite.

The Carbocite Process, of Canton, Ohio, is being actively promoted by its inventor, and rumor has it that a large electric power company is contemplating the installation for use in connection with power-plant work. Among other interesting efforts in this field have been the processes of A. W. Warner, of Petersburg, Va., who was originally working on the Wallace process, but has changed it along lines of his own. H. B. Cannon, inventor of the Cannon Furnace previously described in these columns, is the inventor of another process on which some large-scale experimental work has been done. A. S. Knowles, of New York, is said to have developed a very simple oven for low-temperature carbonization of Illinois coal having the advantage of low installation cost and the production of a good domestic fuel; while K. M. Simpson, of New York, has developed a new and interesting process utilizing rotary retorts.

In the field of complete gasification interest continues to center in the Doherty Process installation at Washington, Pa. Though exact information is difficult to obtain, this three-unit plant is said to be carrying a load of about 20 million cubic feet of gas per day, producing gas of about 170 B.t.u. per cubic foot. One unit will take 120 tons of coal a day and make 75,000 cubic feet of gas per ton of coal.

Powdered Coal

From contracts placed during the last quarter it is estimated that the 1925 figure will again show about double that of the preceding year, this rate of increase in growth having been maintained for the last four years. Undoubtedly, the major trends in this field during the year have been a radical diminution of combustion volumes, accompanied with decreased furnace maintenance, and a growing interest in the use of the unit pulverizer in the larger stations as well as industrial plants. In Pennsylvania a noteworthy achievement has been the successful burning of river anthracite at the



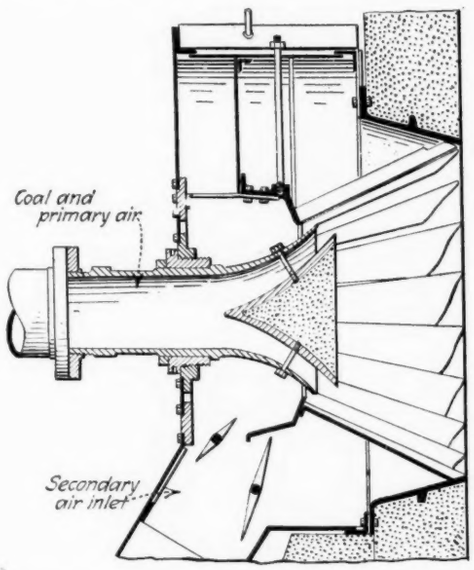
Unit pulverizer of 12,000 lb. per hour capacity equipped with motor-driven feeder and magnetic separator

Holtwood Station of the Pennsylvania Water & Power Company. Following this the Pennsylvania Power & Light Company has contracted for an installation at its Pine Grove Station, in which anthracite fines only will be depended upon for the operation of the entire station. The year has seen remarkable progress in the reduction of combustion space needed by the use of great turbulence of gases. The rate of reaction between carbon and oxygen at any temperature above that of ignition is so much greater than the rate of diffusion of oxygen through an envelope of inert products of combustion, that anything that can be done to disturb the envelope accompanying a particle of powdered coal will aid the natural diffusion of oxygen and accelerate combustion. Successful reduction of furnace volumes, therefore, greatly widens the field of powdered coal in its reduction of initial furnace costs, as well as of boiler-room building costs.

This trend toward smaller combustion volumes has been made possible principally by several applications of the new "well furnace," notably that of the Buffalo General Electric Company, where a new 60,000-kw. turbine will be served entirely by boilers thus fired. At maximum ratings these boilers will be operating at the rate of 40,000 B.t.u. heat release per cubic foot of total furnace volume, which is nearly double the figure that

has been used in previous years, and thus reduces furnace volumes to about half their former size. Similar installations of interest are in course of construction at the Brunot Island Plant of the Duquesne Light Company, the U. S. Metals Company, of Carteret, N. J., and several others.

At the Queensboro Gas & Electric Company and the Buffalo General Electric Company mills operating at speeds intermediate between the low-speed ball mill and the high-speed impact mill have been made or contracted for. These unit mills are of a type hitherto employed only in the central plant. They operate at



Couch pulverized-coal burner for horizontal firing

variable speed with a maximum of about 230 r.p.m. It is hoped that this intermediate speed mill may combine the low maintenance costs of the slow-speed mill with the lower initial cost of the high-speed impact mill, for which reason these installations are being watched with keen interest.

Low Speed Means Less Maintenance

Heretofore high maintenance costs on high-speed unit mills have militated against their wider adoption. During the year there has been introduced on the market a low-speed air swept ball mill, operating at about 30 r.p.m., and about a dozen installations made or contracted for show mill maintenance costs a small fraction of those of the past.

One of the most notable unit pulverizer installations of the year is that of the Brunot Island Station of the Duquesne Light Company, in which eight of the boilers will be served by impact mills. The four most interesting central-station installations installed or contracted for during the year have been those of the Columbia Power Station of the Columbia Power Company, the Fourteenth Street Station of the New York Edison Company, Pine Grove Station of the Pennsylvania Power & Light Company, and the Gould Street Station of the Consolidated Electric Light & Power Company of Baltimore.

In both the unit and central systems, mills have been increased in capacity. Lower power consumption naturally results from the larger units employed, as well as from increasing knowledge of the requirements of correct mill design. Test figures as low as 10½ kilowatt-hours per ton have been reported, and these range up to 15 kilowatt-hours.

For handling ash from pulverized-fuel boilers, a new feature being adopted is the introduction of a transfer hopper with water-collecting gates between the main gates in the bottom of the furnace and the receiving vehicle, whether railway car, lorry or truck. As it is impractical to introduce cold water into the furnace bottom, owing to the rapid deterioration of the hot refractory lining that would result and the formation of steam, this arrangement provides for the necessary quenching without these troubles and eliminates the nuisance caused by dry ash dropping through the atmosphere of the basement. An ingenious method designed to accomplish the same ends consists of forming a water curtain around the falling ashes and collecting both water and ashes in the car beneath.

Increasing interest in pulverized fuel in Europe has been demonstrated by the announcement of a contract for the conversion of the St. Denis Station at Paris to pulverized fuel. This will be by far the largest installation of its kind yet made in Europe and will compare favorably in size with some of the largest installations in the United States.

In the industrial field a novel development which has been widely employed during the last year is the use of the Cannon radiation furnace in which either fuel oil or pulverized coal is burned at very high temperatures within carborundum semi-muffle furnaces, the heat being transmitted through the carborundum by conduction and then by radiation to the object to be heated. Industrial furnace volumes of the order of one-eighth those obtainable with ordinary direct-jet pulverized-coal-fired or oil-fired furnaces have been employed with success.

Evidence that pulverized fuel may not in future be solely confined to the stationary-plant field is indicated in an appropriation by the government to test out at the Philadelphia Navy Yard the use of pulverized-fuel firing with the "well furnace" in connection with marine boilers. Equipment for these tests is now under course of construction, and tests on the boiler will probably begin during the present month. They will be participated in by the United States Shipping Board, Bureau of Mines, and Navy.

Mechanical Stokers

Two new designs of stoker have been brought out, one arranged specifically for burning lignite and the other anthracite culm, also there have been a number of improvements in existing stokers with special reference to handling preheated air, the reduction of unburned combustible in the ash, and through better control of the fuel bed, the reduction of excess air. Test results of the longer and higher superstoker installations have given encouraging figures.

The development of several new suspended arches is promising. One type suspends each brick individually, making possible the replacement of one or more blocks without interference with the balance of the arch.

The application of hydraulic drive is being extended, and one manufacturer is developing a power box equipped with roller bearings.

Stoker sales for the first nine months, as reported to the Department of Commerce by thirteen establishments, show a large gain in numbers and a relatively

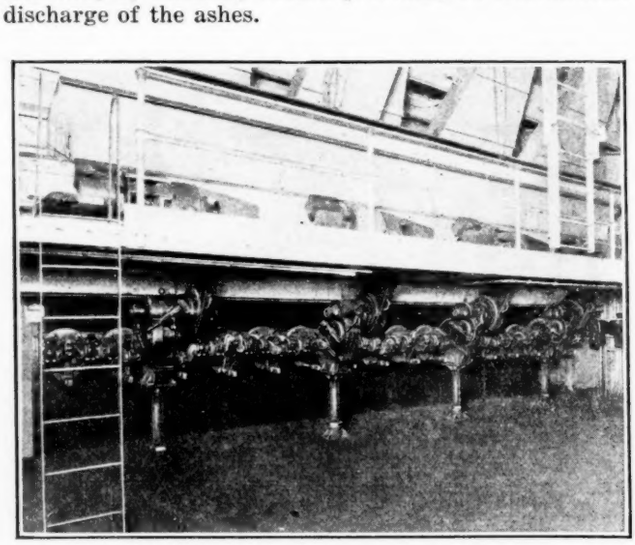
smaller increase in heating surface served over a like period in the previous year, indicating a greater number of smaller stokers for smaller boilers.

In the supply of coal to stokers and in the handling of ash there have been certain developments worthy of note. To maintain a full hopper automatically and to assure a uniform mixture of the fines and the coarser particles of coal across the width of a chain grate, a screw-conveyor type of spreader and several types of spout swinger have been developed.

Ash Disposal Facilitated by Improvements

Turning to the discharge end of the stoker, word has been received of improved water-collecting gates for the ash hopper, which assure a dry ash basement, and with provision in the drain lines for dropping out fine ash carried from the hopper to prevent clogging the sewer. A new departure is the use of transformer oil as the gate-operating medium instead of steam or air. The advantages claimed are more positive control, non-freezing, automatic lubrication and rust prevention. Another expedient to replace steam or air is inclosed grease-packed worm gears driven by a motor under automatic limit controls and also remote hand control.

There is an improved ash sluicing system by which ashes from the hoppers of chain grates or underfeed stokers equipped with clinker grinders are washed from a feed plate or false hopper bottom into the main sluiceway by auxiliary nozzles providing an intermittent discharge of the ashes.



Sixteen-retort underfeed stoker at the ***Edgar Station,*** *Weymouth, Mass.*

Steam Turbine Growth Steady

Large-Capacity Units—Higher Steam Pressure and Temperature—High-Economy Small Units—Continued Refinements in Design—Large Condensers and New Designs Installed—Valves and Piping Show Progress

DURING 1925, the three large builders of turbines in the United States have each built machines of larger capacity than previously, and seem to be developing in the direction of higher speeds. Aside from these features the development of the steam turbine has reached a point where further great advances in efficiency cannot reasonably be expected, although some improvement may be expected through the intensive study and persistent research regarding the behavior of steam in buckets and nozzles which is continuously being pursued by several firms and other agencies. The greatest benefits seem to lie in increasing the pressure and temperature of steam supplied, in conjunction with bleeding for heating feed water, and reheating the steam after it has done a certain portion of the total work. This increases the efficiency of the steam cycle as well as the steam turbine, due to reduction of moisture, and in addition it should considerably reduce bucket deterioration.

The steam turbine is capable of utilizing as high steam pressures and temperatures as can be generated, and in the near future there may be large turbines operating on pressures as high as 1,500 lb. in as satisfactory a manner as present-day units.

During the year there have been put into operation eight machines receiving steam at pressures of 550 lb. and temperatures up to 725 deg. F. These have been thoroughly successful, and the anticipated economies have been fully secured. They have demonstrated the further fact, not previously realized, that with high pressure and reheating the station economy is practically constant over a wide variation in load. Some of these machines have been operated for some time satisfactorily without reheating, and in all cases the reheating operation has proved entirely satisfactory.

As a scientific basis for the advance to high pressures, the American Society of Mechanical Engineers, through its Research Committee, is prosecuting vigorously the investigation of the thermal properties of steam, and through the efforts of the General Electric Company the information so far available has been put in the form of a Mollier chart which has been published by the Society. This work is continuing, and in due time the final result will appear in the shape of tables and charts of unparalleled accuracy. While the influence of this work on turbine design will never be very conspicuous, nevertheless, the refining of information on this important subject is of no small value to the designer, and to the user as well. Better information makes possible better design and better efficiency, and the results will save money for the user of the machine as long as it operates.

High Steam Pressure

The 1,200-lb. pressure turbine in the Edgar Station at Weymouth near Boston, Mass., has gone into service and is operating satisfactorily. This confirms the opinions expressed by turbine designers generally, to the effect that there is no difficulty in building a turbine to operate under any desired steam pressure. It is not

unreasonable to expect that the future will see a considerable increase in the number of machines operating on pressures up to 1,200 or 1,500 lb. per sq.in. and perhaps even higher. On the other hand, the use of these very high pressures is accompanied by increased condensation of moisture in the low-pressure stages of the turbine, and the use of reheating is almost necessary if the turbine buckets are not to be subjected to excessive wear. For the high-back-pressure turbine this ceases to be a disadvantage, because the steam is not expanded to a low enough pressure to give rise to any serious difficulty with entrained moisture.

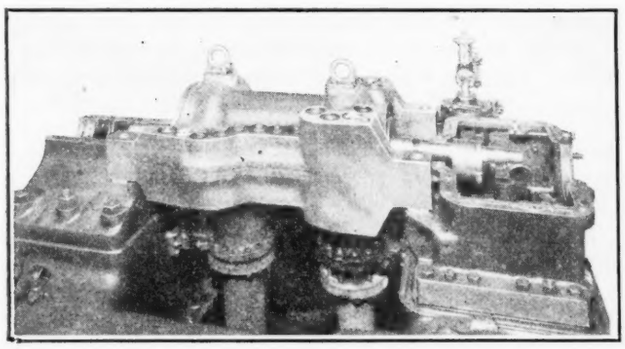


Fig. 1—This General Electric turbine operating in the Edgar Station at Weymouth, Mass., receives steam at 1,200 lb. per sq.in. and exhausts through a superheater into the 350 lb. steam system of the rest of the plant.

The use of high-pressure steam turbines superposed on existing power systems and exhausting to the present high-pressure steam piping system has been given some attention, and while the idea is not entirely new, it seems to be gaining favor.

Small Units of High Economy

The manufacturers seem inclined to develop small turbine units of high economy. While high efficiency is not so important as first cost and simplicity in turbines of less than 1,000-kw. capacity, machines ranging from 1,000 to 6,000 kw. are frequently demanded with as high efficiency as is by any means obtainable. This has been done by at least one manufacturer through the design of such turbines with as high as 40 stages.

The same manufacturer has also brought out improved designs of small turbines, some as small as 25 kw., for generating electric power in office buildings and other places where economy is desirable.

During the year some turbine builders have brought out small high-speed turbines, driving through gears. These machines, operating at suitable high speeds, develop power with low steam consumption. It is evident that the manufacturers are alive to the demands of industrial-power users for higher economy in the generation of power. In many cases this is accomplished without undue increase in the cost of equipment.

In the design of small high-speed turbines for high steam pressure, several builders are making the turbines with overhung shafts so that there is no high-pressure shaft packing, since the shaft does not emerge from the casing at the high-pressure end. This design eliminates high-pressure steam leakage and simplifies the problem of aligning a long series of bearings.

There is a pronounced tendency among industrial users of turbines to use the higher steam pressures that have proved so satisfactory in the larger plant. This is especially true in plants requiring process steam, where high back-pressure turbines have in several instances supplanted boilers supplying live steam for heating service.

Steam Reheating During Expansion

As with the air preheater there has been evidence in practice that the reheating of steam at a certain point of its expansion in the turbine has shown greater advantage than theoretically could be expected, owing to the deteriorating effect of the moisture in wet steam on turbine blading and the increase in surface friction. In the few high-pressure stations that have resorted to reheating, the method has been to install special secondary superheaters in the boiler setting with comparatively large pipe connections from and to the turbine, complicated by a number of precautions to guard against expansion and eventualities in case of a sudden reduction in load or changes in furnace conditions.

While this method is perhaps the most economical, it has been suggested that a simpler arrangement would be a separately fired superheater, located in the turbine room, which in plants using all electrical auxiliaries also might preheat the feed water.

Another plan for which special equipment has been developed is a reheater located at the turbine, using live steam from the boilers. The outstanding feature of this method is the simplicity of regulation. All that is necessary is the adjustment of a steam valve. The attainable reheat temperature is low, but the thermal gain is nevertheless great.

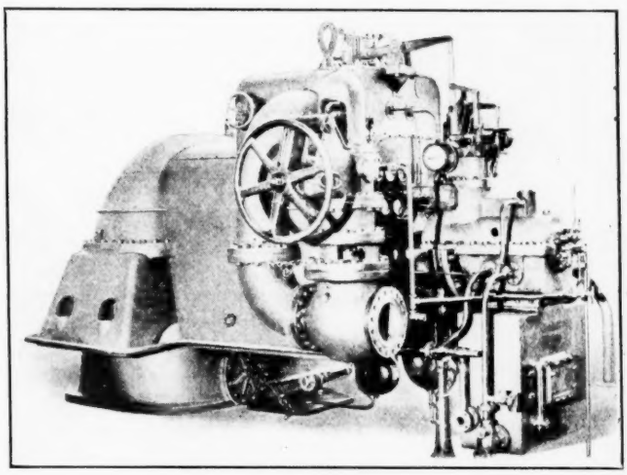


Fig. 2—This 6,000-kw. Westinghouse turbine has a maximum rating of 7,500 kw. and is arranged for four-stage bleeder heating. The turbine operates at 3,600 revolutions per minute

This illustrates the fact that the advantages of extraction heating are by no means confined to large turbines, but apply equally to small machines. As a matter of fact, the use of extracted steam for heating services other than feed water may make this type of turbine of greater advantage to the small industrial plant than to the large central station.

Combination Turbine and Engine Plants

In the use of exhaust steam and the development of combination turbine and engine plants, so as to develop the maximum available work from steam and to use the exhaust for heating, there have been no develop-

ments that might be called new. On the other hand, there has been continued and perhaps increasing emphasis on the saving to be effected by these methods and a number of installations have been made in which extracted and exhaust steam is available in whatever quantities are required by the heating conditions, the load on the turbine being adjusted, in many cases automatically, to give the desired steam quantity.

Details of Design

As a result of the combined work of the research scientist and the designing engineer, there is growing confidence in the ability of the manufacturers to produce turbines that are entirely reliable under all conditions of normal operation. The uneasiness which was widespread a few years ago has been largely dispelled. Attention that formerly was centered on the fear of disastrous accidents, is now directed to the securing of more economical plant operation.

The work of the late Wilfred Campbell on the tangential vibration of turbine buckets has been continued since his death by Mr. Heckman, whose report is a valuable contribution to the literature available to the turbine designer.

Further research on the causes of shaft vibration has developed the fact that the behavior of the oil film in a journal bearing has, under some circumstances, a pronounced effect in setting up vibration. This, it has been shown, may be stopped by the use of shorter bearings, or by designing a shaft so that the critical speed is remote from the running speed. Preferably, the critical speed should be above the running speed.

The idea that complete safety of a turbine lies in low speed is gradually disappearing with a realization that machines operating at comparatively high speed are just as safe as those at lower ones. Safety lies in avoiding heat and vibration stresses. If they are present it is only a question of time when trouble will occur, whether the machine is low-speed or high-speed.

It is likely that no bucket failure ever occurred in any turbine due to centrifugal force alone.

Considerable attention has been given to the material of turbine blades. The effort has been to develop a material that will resist wear due to erosion from the impact of solids or fluids, or to corrosion resulting from chemical action by liquids or gases.

One development has been the extended use of stainless steel for shaft sleeves in turbines and to some extent for the production of buckets also.

With the growth of turbines to larger sizes, together with higher initial steam pressures, extraction heating and steam reheating, it becomes increasingly necessary to separate the turbine casing into several barrels and two schools of design are evident. One places these barrels in tandem on a common shaft (with couplings between barrels), the other connecting each turbine section to a separate generator after the fashion of a cross-compound steam engine.

In the use of reheating turbines it is increasingly recognized that safeguards must be provided to prevent overspeeding the turbine when the governor closes the throttle, due to expansion of the steam contained in the reheating piping. This has resulted in the development of ingenious governing devices to by-pass this stored steam to the condenser in case of overspeed.

The desire of the operating man continues to be for a turbine of more rigid construction and simpler mechanism, as far as may be consistent with high economy.

An interesting development, which has been operating for some time, but was discussed publicly only during the past year, is the elimination of the atmospheric relief valve on the turbine exhaust and the substitution therefor of a mercury-column-actuated mechanism designed to trip the turbine throttle when the vacuum falls to some predetermined value, such as 20 inches of mercury. This is further safeguarded against disaster by installing a diaphragm designed to be weak against internal pressure and strong against external pressure, so that if the throttle fails to trip and the pressure in the condenser rises materially above atmospheric pressure, the diaphragm will rupture and release steam to the atmosphere of the engine room. The advantage of this arrangement is the elimination of the expensive and bulky atmospheric relief valve and piping which have heretofore been considered essential to the safe operation of large turbine units. In the case of small units the valve and piping are not so bulky, and it is possible that they might prove cheaper and easier to install that the more elaborate control.

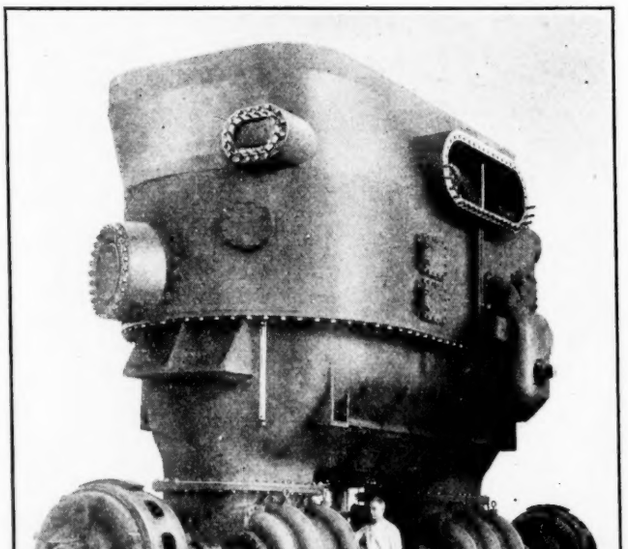


Fig. 3—The largest single jet condenser in the world, made by the Elliott Company, serves a 35,000-kw. turbine in the plant of the Narragansett Electric Lighting Company at Providence, R. I.

When condensing 350,000 lb. of steam per hour, with water at 70 deg. F., it will maintain a pressure of 1.5 in. of mercury absolute. The water is extremely corrosive, and the condenser is lead lined at vital points.

Lubrication

Continued attention is being given to the treatment of lubricating oil and the proper design and operation of lubricating systems of a steam turbine.

It is becoming increasingly evident that it is essential to exclude water from lubricating oil, and that this can best be done by a continuous process of filtration, using one of several types of apparatus available on the market. In addition to this it seems necessary peri-

odically to remove the entire batch of oil from the lubricating system of the machine and allow it to rest for a season and to subject it to heat and perhaps chemical treatment and filter it slowly through an effective filter.

Condensers

During the year publicity was given to two condensers of mammoth proportions. One of these was the largest single jet condenser ever constructed, which is to serve a 35,000-kw. turbine in the enlarged plant of the Narragansett Electric Lighting Company of Providence, R. I. It will use 36,000 gal. of cooling water per minute. The other is the world's largest single surface condenser being installed in the new Richmond Station of the Philadelphia Electric Company. It has 70,000 sq.ft. of surface and with the auxiliary equipment weighs nearly one million pounds. Through its fifty-one miles of one-inch tubing will be passed a maximum of 144,000,000 gal. of circulating water in twenty-four hours.

The Wheeler Condenser & Engineering Company has developed a somewhat unusual design of surface condenser, in which the tubes are grouped in a number of cylindrical bundles. By this means the exhaust steam has unimpeded access to large heat-absorbing surface. In the center of each cluster of tubes is a vacuum tube for collecting and removing the uncondensed gas and conducting it to the vacuum-pump suction. The pump suction is a central chamber midway of the length of the condenser, and therein all the uncondensed gas must pass over the tube surface where it is effectively cooled and devaporized.

Attention continues to be directed to the cleaning of condenser tubes. No entirely new methods have been proposed, but many modifications of methods previously used have been advocated. It appears that the fact is that conditions vary widely from place to place, depending upon the nature of the water and the material that it carries, and upon the manner of operating the condensers. A method of cleaning that proves entirely satisfactory in one case, will be utterly useless in another.

New forms of condenser-tube packing have also been suggested, at least one of these being driven into the gland and holding its place so tightly that no screwed ferrule is necessary. In connection with this packing a substitute for the ferrule is a long sleeve designed to support the tube end in such a way as to reduce vibration and thereby increase the life of tubes.

The Westinghouse company has developed a double-deck three-stage air ejector for condenser service which will show a considerable saving in steam consumption over the two-stage type now commonly used. Each of the two inter-condensers is divided into two sections, through the first of which is circulated condensate from the main turbine, while raw makeup water is circulated through the second section. In the after-condenser condensate from the main condenser is used.

Valves and Piping

The growing use of high pressures and temperatures has naturally been met by the refinement of valve and fittings design, and by the increased use of special materials, such as Monel metal, stainless steel, and such special schemes as mild steel electroplated with copper and nickel. These developments have been gradual, and no startling changes are to be reported.

Development continues in the field of safety valves, whose service becomes more exacting as the pressure rises. The severe cutting caused by the most minute leaks at high pressure makes it increasingly desirable to have safety valves that will seat perfectly, or else to arrange the boiler so that the main safety valves will rarely lift. This is done, in some cases, by the use of a small pilot pop valve mounted with a gate valve in its connection and set to blow somewhat below the pressure for which the main valves are set. This small valve can

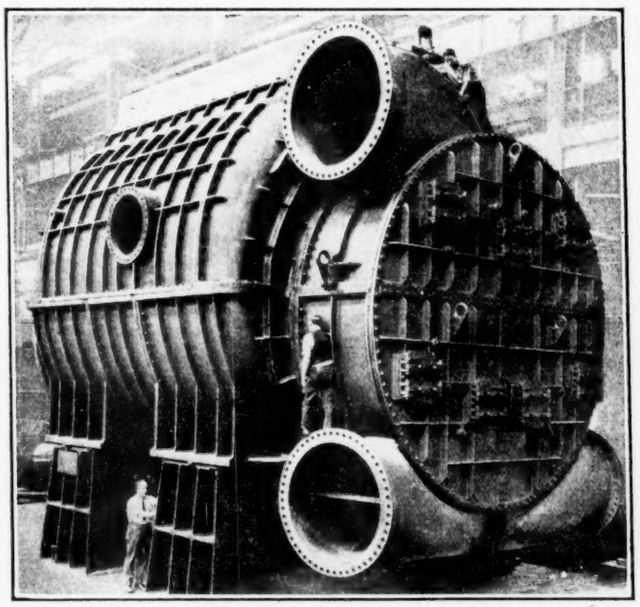


Fig. 4—This 70,000-sq.ft. Westinghouse surface condenser, the largest of its type, serves a 50,000-kw. turbine

be overhauled without shutting down the boiler, and serves as an alarm to the operator. Safety is unimpaired, since the main valves, mounted directly on the boiler, are of the capacity demanded by the Boiler Code.

There has been substantial progress in the establishment of dimensional standards for pressures up to 900 lb. per sq.in., and the American Engineering Standards Committee is carrying this work forward to cover still higher pressures.

With the steam use in the plant becoming more and more complicated, together with higher pressures and temperatures, there is a strong tendency toward the more general use of motor-operated valves. Not only are they of value in emergencies, but also during the events of normal operation, for which the manual operation of valves is becoming increasingly difficult.

In the field of joints there seems to be a preference in certain quarters for joints in which welding takes the place of the gaskets, although there are several instances of high-pressure plants where gasket joints are giving no trouble.

There is also some use of fully welded joints, in which the welding carries the load in addition to acting as a seal. Such joints are used especially in building up special headers and fittings.

A number of plants have been built with seamless steel tubing for high pressure steam and water piping.

It seems safe to say that, while difficulties have not been fully eliminated, piping, valves and fittings are in no way backward in the field of modern plant design.

The Steam Engine as a Factor in Industrial Power

Special Investigation by Power Shows Trends in Types and Applications to Industries—Figures Show Steam Engine Holding Its Own

THE results from a stationary steam-engine survey,[1] based on data from representative manufacturers indicates a normal annual production of about 600,000 hp., of five principal types, which is being currently installed in a great variety of industries. According to various sources the total steam-engine prime mover capacity in manufactures, mines, utilities, and buildings is slightly over twenty million horsepower at the present time. This total has been maintained at substantially the same level for the past fifteen years, in spite of the growth of the steam turbine and the oil engine.

A study of Fig. 1, shows, in a general way, how the progress of the more recently introduced prime movers has resulted rather in the increase of total power capacity installed than in the reduction of the field for the steam engine. True, a close scrutiny of the trend of

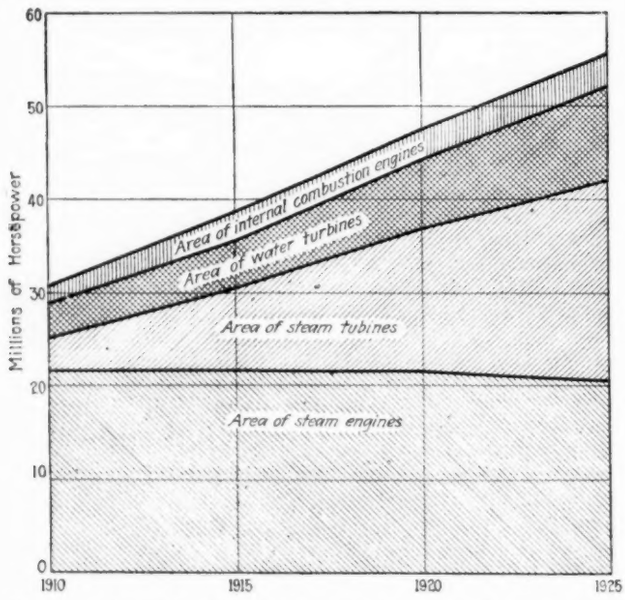


Fig. 1—Growth of total capacity of stationary prime movers installed in industry, including manufactures, mines, utilities and buildings

the steam engine installed capacity from 1920 to 1925 shows an annual shrinkage of about two hundred thousand horsepower. But this rate of decrease is so slight compared with the total installed capacity, that even if it were to continue it would take ten years to reduce the present total by 10 per cent.

[1]By "stationary steam engines" is meant (for purposes of this survey) any reciprocating steam engine permanently fixed on a foundation for operation on land (not marine or portable) regardless of whether it drives machines, generators, blowers, compressors or pumps. It includes both primary and auxiliary engines and includes separate units as well as units built integral with blowers, compressors or pumps. Where no horsepower rating is used, as in pumps, a rough estimate of equivalent horsepower rating was used.

Popularity of Types

The survey shows, judged by total horsepower, that the four-valve and uniflow types take precedence over other types. On the other hand, judged by the total number of engines, the simpler single-valve throttling engine still holds the lead. In other words, the four-valve and uniflow engines are built in large units, while

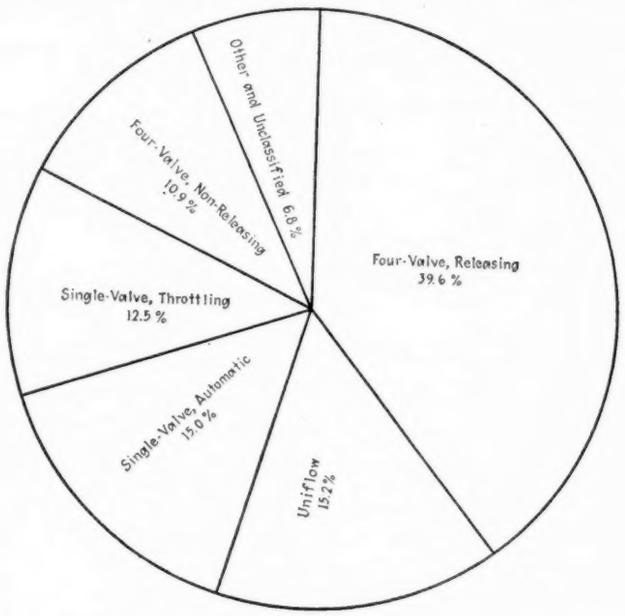


Fig. 2—Distribution by type of total horsepower reported, of stationary steam engines built from 1920 to 1924

the simpler engines are built in small units. Figs. 2 and 3 bring out this situation in a striking manner.

Note how Fig. 2 emphasizes the total horsepower built in four-valve releasing and uniflow types. It shows respectively 39.6 per cent and 15.2 per cent of the total horsepower built to be of these two types. On the other hand, Fig. 3 emphasizes the total number built of single-valve throttling engines; in all 52.3 per cent of the number of engines reported were of this type. In attempting to draw conclusions as to the future trend of the various types, it must be kept in mind that the industry is of long standing and well-stabilized and that in the first place any sudden shifting from one type to another is unlikely. In the second place the extent to which the four-valve engine, and the still newer uniflow have already been accepted, would indicate that these types, though continuing to increase in popularity, cannot be expected to completely replace the single valve engines, for many years to come.

The latest reports for 1925 indicate that the usual number of four-valve engines has been installed during

the year. The biggest size in this type so far built, has a normal rating from 8,000 to 10,000 hp. and can carry maximum loads of 18,000 i.hp. There is reported a continued rise in steam pressures and temperatures

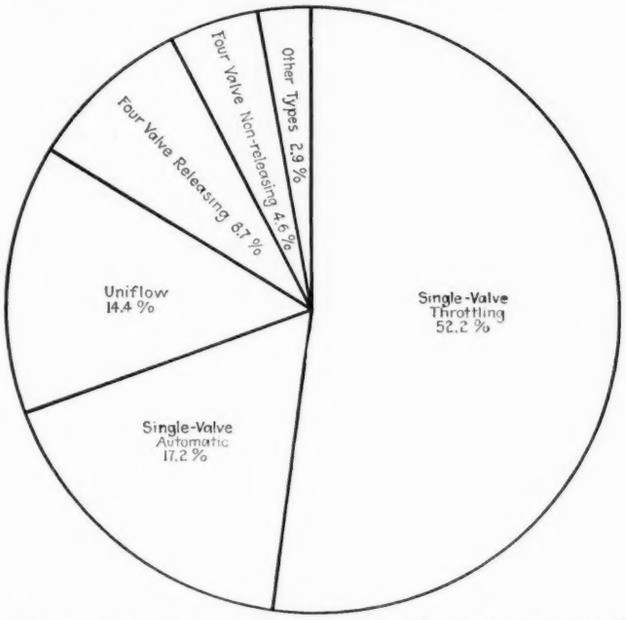

Other Types 2.9 %
Four Valve Non-releasing 4.6 %
Four Valve Releasing 8.7 %
Uniflow 14.4 %
Single-Valve Throttling 52.2 %
Single-Valve Automatic 17.2 %

Fig. 3—Distribution by type of total number reported, of stationary steam engines built from 1920 to 1924

employed, and also the use of comparatively high back pressures, running up to 100 lb. Engines for driving air compressors of large size are in considerable demand.

Installed in Many Industries

The industries that have installed steam engines during the last five years reveal recent applications and

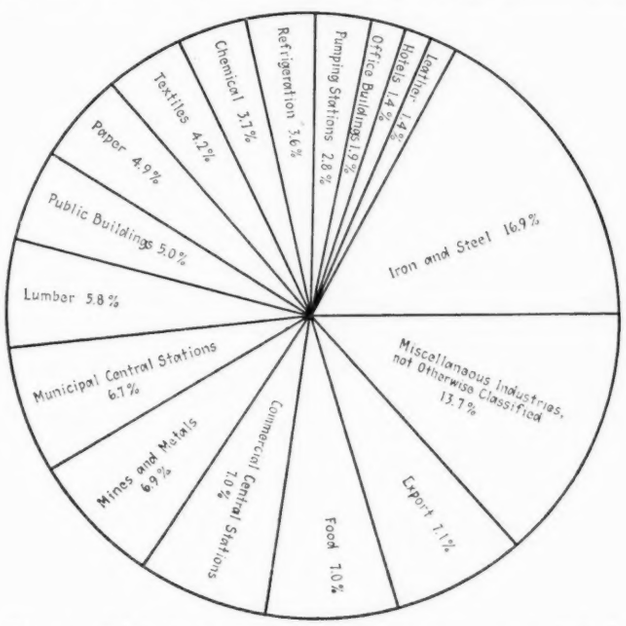


Fig. 4—Distribution of total horsepower reported, by industry, of stationary steam engines built from 1920 to 1924

serve as the best guide for the immediate future. Fig. 4 shows how the reported horsepower was distributed among various industries. The lack of predominance of any one industry, except perhaps the steel industry, indicates that the steam engine still has an unusually broad field of application as a prime mover. The steel industry has absorbed 16.9 per cent, and no other single industry has absorbed more than 7.0 per cent of all the steam engines produced during the five-year period surveyed.

It is interesting that central stations, both municipal and commercial, are large users of steam engines.

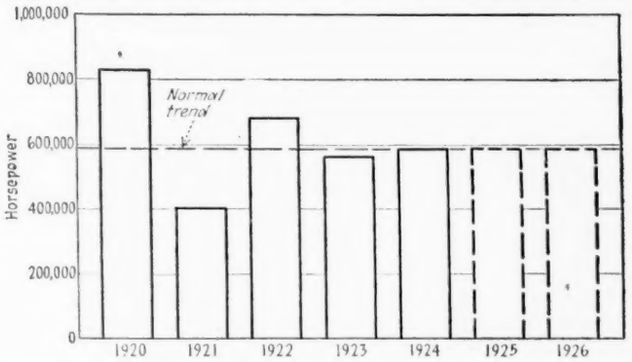


Fig. 5—Estimated total steam engine horsepower built annually from 1920 to 1924 inclusive. The totals shown for 1925 and 1926 assumed same as for 1924

These are the stations serving the smaller communities. Because of incomplete returns from certain builders the refrigeration industry is probably understated, but the remaining industries are shown in nearly correct proportions.

How the estimated normal yearly production compares with the five years for which data were secured is shown in Fig. 5. The variations from normal are due apparently to general business conditions. The year 1920 was a boom year and shows greater production, while 1921 was a year of depression and consequently showed less production. It is assumed that the same rate of production as held from 1922 to 1924 will hold for 1925 just past, and is predicted for 1926.

To Remain an Important Factor

All the evidence shown for the steam engine, of stability of types, broad distribution by industries, and a large normal production of about 600,000 hp. annually, demonstrates that the steam engine is holding its own, and will continue to be an important factor for some time to come.

The majority of steam engines installed in the past five years have been for auxiliary drive, fan, compressor and like services rather than for power generation. For prime mover use the steam engine will continue to find an active field where non-condensing operation is desired and where there is no use for bled steam, inasmuch as the reciprocating engine is generally conceded to have a better thermal efficiency under such conditions than has its competitors.

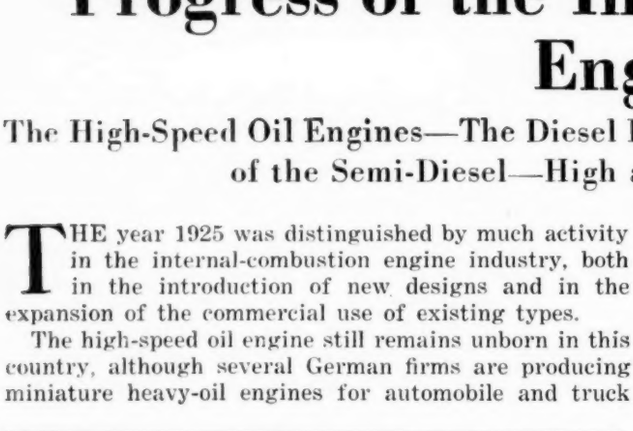
[Concurrently with the survey of steam engines, presented in this article, a survey of the steam-turbine field is under way. Because the data on turbines are incomplete up to the present time, the results of that survey will be published in a later issue. The only figures on turbines used in this article are based on the Census and preliminary estimates. Upon the completion of the turbine survey, the internal-combustion engine and water turbines will be studied.—Editor.]

Progress of the Internal-Combustion Engine

The High-Speed Oil Engines—The Diesel Locomotive—Large Units—Transformation of the Semi-Diesel—High and Low-Speed Gas Engines

THE year 1925 was distinguished by much activity in the internal-combustion engine industry, both in the introduction of new designs and in the expansion of the commercial use of existing types.

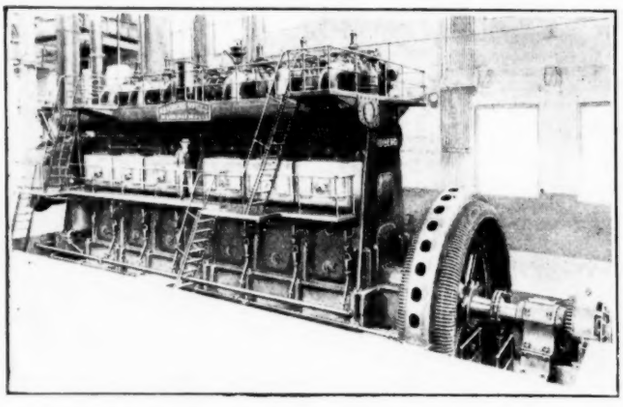
The high-speed oil engine still remains unborn in this country, although several German firms are producing miniature heavy-oil engines for automobile and truck



A 1,000-horsepower Diesel locomotive

service, even including a unit for motorcycles. In England William Beardmore & Co. have developed a Diesel for rail-car service, weighing less than 12 lb. per brake horsepower. Several American builders are developing high- and medium-speed engines, but none is prepared to make public announcement, the engines still being in experimental stages.

The desirability of such engines for rail cars and buses is apparent, and the transcontinental and return

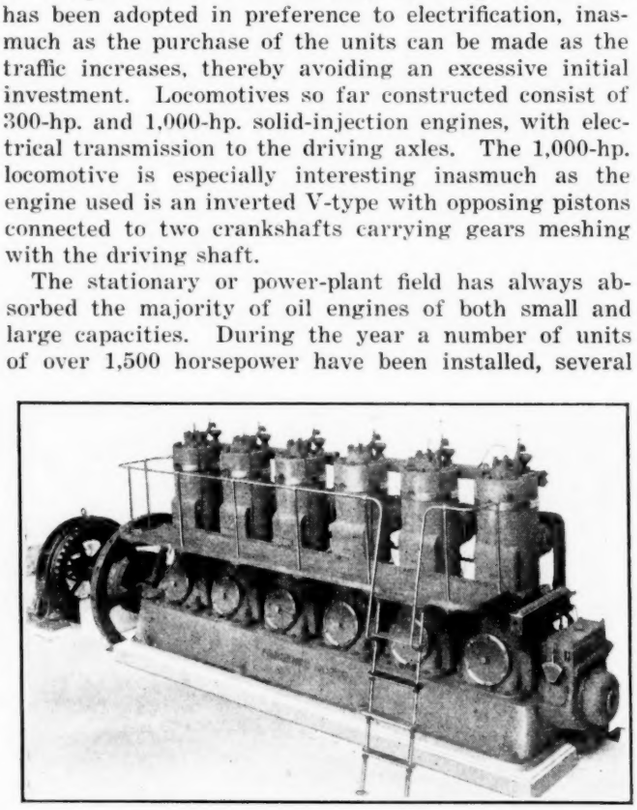


3,750-horsepower Diesel for Panama

non-stop runs of the Canadian Northern car equipped with the Beardmore engine are illustrative of the capability of the oil engine to operate continuously at high speed.

The Diesel locomotive has apparently come into its own; already four railroads have such units on order or in operation. In one instance this type locomotive has been adopted in preference to electrification, inasmuch as the purchase of the units can be made as the traffic increases, thereby avoiding an excessive initial investment. Locomotives so far constructed consist of 300-hp. and 1,000-hp. solid-injection engines, with electrical transmission to the driving axles. The 1,000-hp. locomotive is especially interesting inasmuch as the engine used is an inverted V-type with opposing pistons connected to two crankshafts carrying gears meshing with the driving shaft.

The stationary or power-plant field has always absorbed the majority of oil engines of both small and large capacities. During the year a number of units of over 1,500 horsepower have been installed, several



Solid-injection engine of 360 horsepower

going into electric lighting plants. Florida towns of miniature size have developed almost overnight into cities of the first class. To meet the enormous increase in power demands, many of these cities have installed Diesels, among these being Hollywood-by-the-Sea where an original installation of a 1,250-hp. Diesel has been augmented by two 2,200-hp. units. Other Florida installations include Fernandia, Cocoa, Sarasota, South Tampa, Kissimmee, Perry, Lake Worth and Jacksonville.

The number of new oil-pipe-line installations dropped below the records of previous years. The outstanding development was that of the Ozark Pipe Line Corporation, where a contract was placed for twenty-five 270-hp. 3-cylinder 225-r.p.m. engines. These are to be direct connected to 14,000-bbl. pumps operating against 800 to 1,000 lb. pressure.

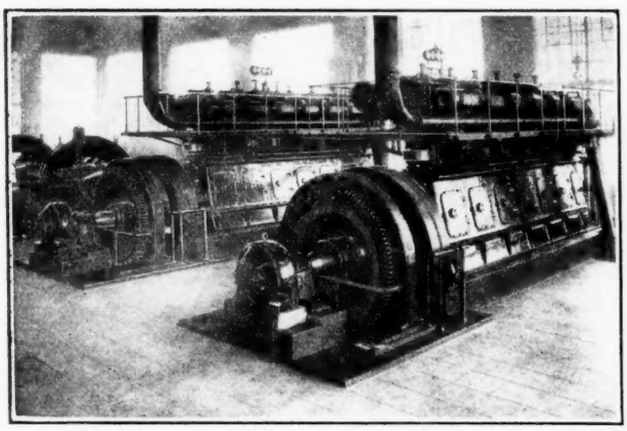
Another outstanding pipe-line order was one for export to South America. These units, which are to pump oil from the Colombia oil fields to the coast, some 250 miles away, consist of twelve 200-hp., four 260-hp. and

ten 500-hp. solid-injection Diesels of the vertical type.

Many ice and cold-storage plants have installed Diesels; usually, however, the engines are below 300 hp. in rating, although below is shown a Santa Fe R.R. icing station with two 500-hp. units, the ice machines being motor driven. A unit consisting of the compressor cylinder mounted upon the frame of the horizontal engine has found considerable favor in ice plants, inasmuch as both the first cost and the floor space are reduced.

The Shipping Board orders for Diesels of 3,000 hp. have permitted several builders to proceed with the development of units of this capacity, both single and double acting. At present only one, a two-stroke-cycle double-acting engine, has been completed to the point where tests have been run, but other builders have their units in the erecting shops. Many orders have in the main been for engines under 1,000 hp.; the number going into tugs, fishing boats and dredges is especially large. The arrival of the "Gripsholm," the 17,000-ton passenger motorship at New York early in December, attracted much attention. The main driving units are four-stroke-cycle, double-acting 8,000-hp. Diesels. These are the largest oil engines so far put into commercial use and are noteworthy for the high piston speed of 1,250 ft. per min. at 125 r.p.m. Two other Diesels of 10,000-hp. each are being built in Ireland; these are of the same design as those of the "Gripsholm."

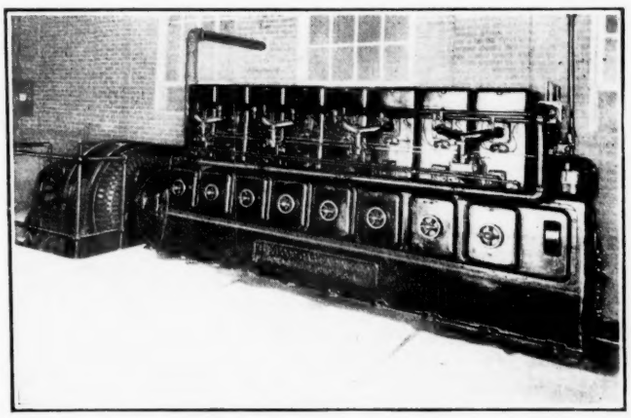
American builders, by reason of a lack of demand for such large engines, have been forced to confine engine sizes to capacities below 4,000 hp. While the Shipping Board orders have encouraged the development of 3,000-hp. marine units, the three 3,750-hp. Diesels ordered by the Panama Canal Commission, one of which is shown on page 18, are the largest engines so far built in this country. These are of the 6-cylinder single-acting two-



Diesel engines in refrigerating plant

stroke-cycle design and are to be used as stand-by units along the canal so that in case of trouble at the hydro-electric station, power can be supplied to the lock mechanism.

One of the wonders of the engineering world is the number of oil engines ranging from about 200 downward to 10 hp., that are installed each year. In the face of decreasing costs of purchased energy the volume of sales of the semi-Diesel has shown a marked increase each year. In the early days when the engine's cycle was not fully understood, fuel consumption was a minor consideration, the builders' efforts being centered on increasing the reliability of these engines. Operating troubles having been overcome, attention during the year has been turned upon the problem of decreasing fuel consumption as well as increasing the ease of starting from a cold condition. Designers have acted almost in unison in raising the engine's compression pressure. In fact, practically all the well-known semi-Diesel builders have converted these units into cold-starting, high-compression units. Fuel consumption has decreased, as has also the consumption of lubricating oil through the adoption of reclaimers as a part of the engine's equip-



Gasoline engine for standby service

ment. The increase in compression pressure has permitted a higher mean effective pressure to be carried, resulting in higher ratings. Broadly, ratings have been increased approximately 20 per cent; the next step will probably be in a redesigning of the scavenging arrangement in these two-stroke-cycle engines with the result that through better scavenging the engine efficiency and output will be bettered.

In the two-stroke-cycle solid-injection Diesel now employing a separate scavenging pump, there is a tendency toward the use of blowers in place of reciprocating air pumps.

In the four-stroke-cycle solid-injection engine of medium compression no innovation has been introduced. Larger engines have been built, 1,000-hp. units becoming a standard product.

An application of the internal-combustion engine, which, while not new, has shown a decided increase, is breakdown service. This is a complete reversal of form from the situation some 15 years ago, when the reliability of the gas and oil engine was so questionable that some other stand-by equipment was deemed necessary. At present, in many industries where energy is obtained over long transmission lines, gas- and oil-engine stand-by units are becoming common. This is very apparent in the telephone field, in the mining field, in municipal works and other industries where stoppage cannot be permitted. One manufacturer of gasoline engines places almost his entire output in such service.

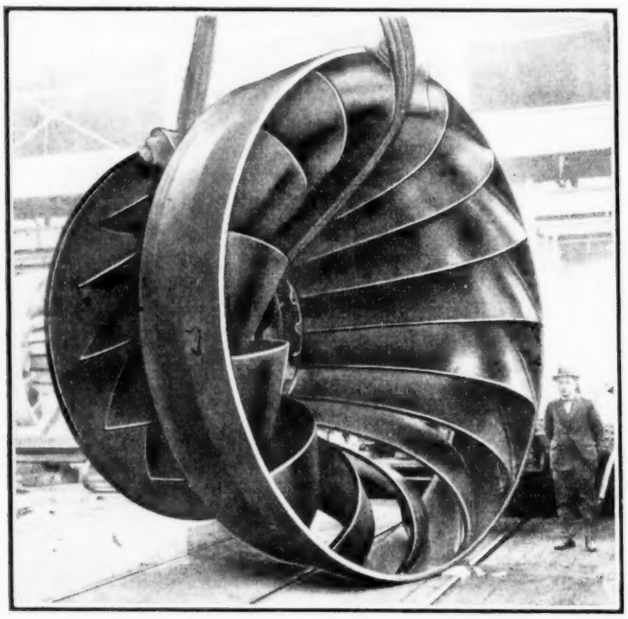
Little activity has been shown among the builders of large gas engines, a few having been installed in natural-gas compressor stations. In the steel works several large units have been installed to replace older units, and one 48x60-in. 3,600-kw. twin-tandem unit has been put in for generator drive, using blast-furnace gas. The large producer-gas engine has practically disappeared, but at present one builder is developing a gas producer for heating and engine fuel use on farms.

Activity in Field of Water Power

One Million Horsepower in New Contracts Reported—Propeller Type Shows Gains—Increased Efficiency Renders Development of Many Low-Head Sites Commercially Economical

WHEN the capacity represented by the orders for new equipment are combined with that put into service during the last year or now being installed, water-power development in this country and Canada takes on a very healthy aspect. These figures total over 2,500,000 hp. Of this approximately 1,000,000 hp. was reported as new contracts. There were some large projects completed or nearing completion. Among these are 400,000 hp. in the Quebec Development Co.'s plant at Isle Maligne on the Saguenay River and 260,000 hp. in Muscle Shoals plant. Although the largest single order placed was for 108,000 hp., there were a considerable number for capacities ranging from 20,000 to 90,000 hp. so that the total approached nearly 1,000,000 hp. Of these figures about 150,000 hp. is for export to South America and Japan. One of the orders was for two 40,000-hp. impulse units to operate under an effective head of 2,450 ft. at Santos, Brazil.

Reports from the Pacific Coast would indicate that the water shortage that has been experienced during the last five or six years has had little or no effect on

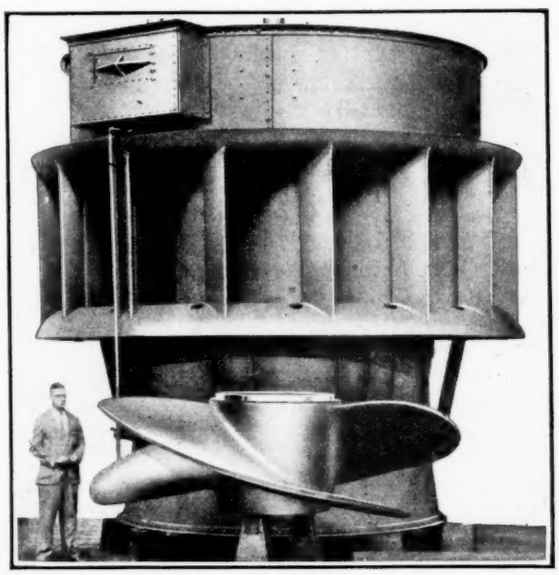


One of eight 50,000-hp. runners in plant of Quebec Development Company

the continued development of hydro-electric plants, for it is known that shortages of this sort come in cycles and there is a sufficient record of previous experiences at hand to warrant the feeling that the cyclic period of water shortage is over, and there may be expected following a period of ample water supply for some time to come.

In the Southeast, hydro-electric operations have experienced the lowest water during the last year of any time in their history. This has caused attention to be given to the construction of supplementary steam plants in that section.

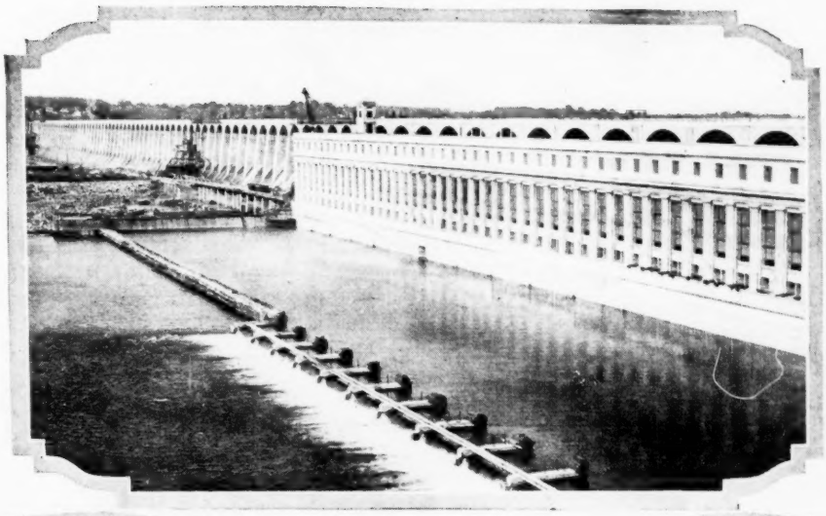
Since the war important advances have been made in steam plants toward reduction in costs of producing



Casing and runner for 1,160-hp., 14-ft.-head, propeller-type unit

power from fuel. Developments of equal importance in the hydro-electric field are not lacking as is indicated by the large number of low-head plants under construction. Of the contracts let with the large companies during the last twelve months over 150,000 hp. was for heads of 37 ft. or less. A number of these were for heads around 8 or 9 feet. At these low heads the cost of construction per unit capacity is necessarily high, and it is a tribute to the waterwheel manufacturers and plant designers that they have been able to make modern developments of this kind possible, notwithstanding the large increase in costs for labor and materials, improvements in steam-plant designs and low-priced fuel.

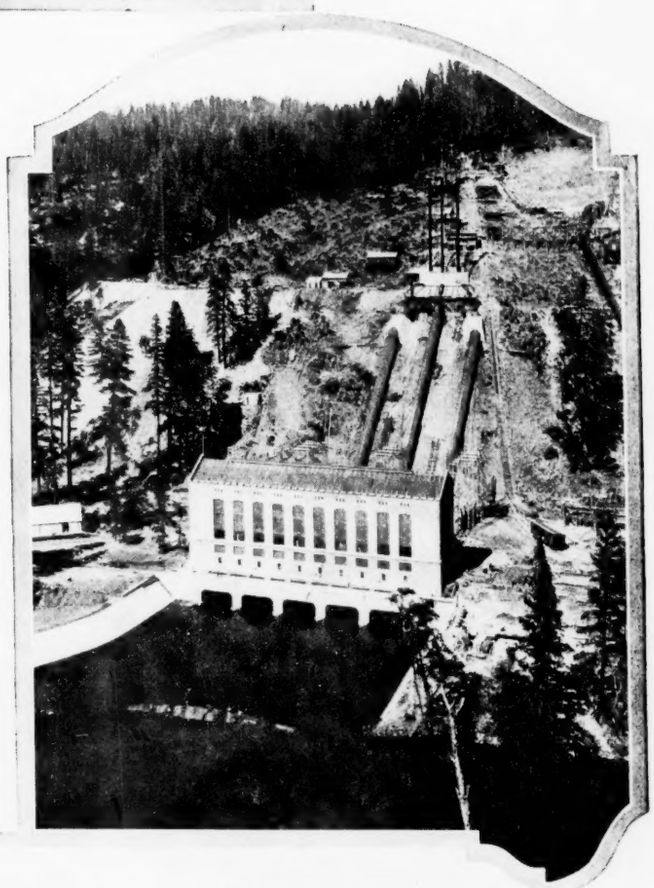
The fifth annual report of the Federal Water Power Commission also indicates active interest in hydro-electric developments. During the five years that the Water Power Act has been in force, there has been filed with the Commission, after eliminating duplications, applications for projects that involve an aggregate estimated installation of 24,000,000 hp. While a considerable number of these applications are for projects that will not be built for many years, the aggregate of those that are reasonably certain of construction in the near future involve more than twice the water-power capacity in operation when the Federal Water Power Act was passed in 1920. In the last fiscal year of the Com-

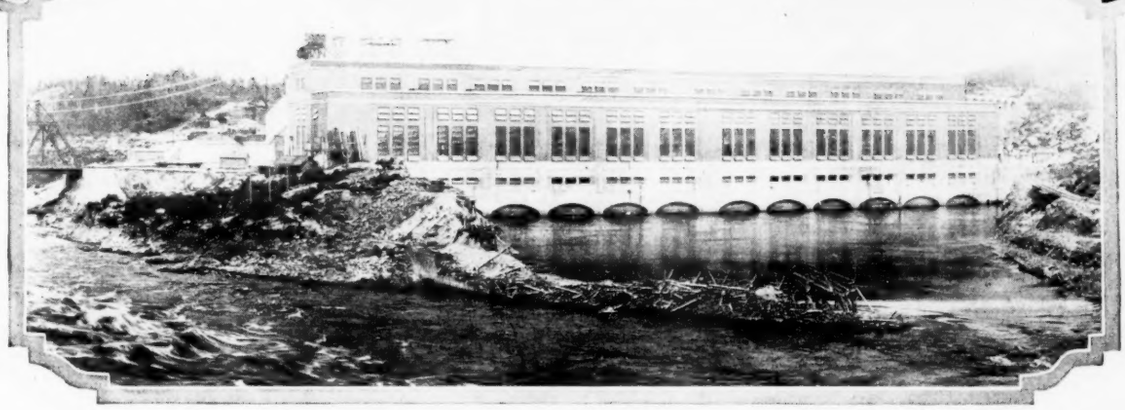


Left — Muscle Shoals power house will eventually contain 610,000 hp. in 18 units

Below — Plant of Illinois Northern Utilities Company contains five 800-hp. units operating under an effective head of 7 ft. These are the lowest-head turbines of this capacity in operation

Below — Pit River No. 3 plant of the Pacific Gas & Electric Company contains three 33,000-hp. units

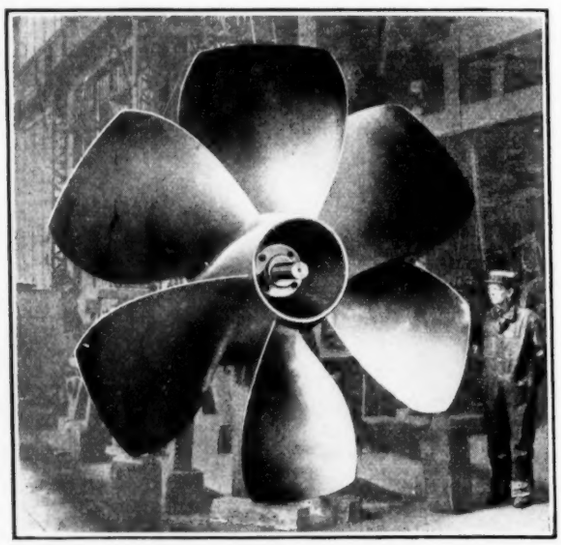




Quebec Development Company's plant on the Saguenay River has eight 50,000-hp. units in operation, with room for four more

mission applications for 80 power projects were filed, having an estimated capacity of 620,000 hp. In this same period 18 permits and 53 licenses, with an estimated capacity of 1,766,000 were issued. At the end of the fiscal year there were outstanding 70 permits and 180 licenses aggregating 8,745,000 hp. Eighty-three projects with a prospective installation of 2,646,000 hp. had been completed or were under construction.

At the time of writing last year's review, the Conowing development appeared to have good prospects



Runner for one of five 800-hp., 8-ft. head, turbines, at the Illinois Northern Utilities Company

of being well under way by this time. However, a number of controversies have held up starting the work during the last year. As now proposed this project involves an initial installation of 240,000 hp., an ultimate capacity of 400,000 hp. and a capital expenditure of about $50,000,000.

Although four units in the Muscle Shoals plant have been put in operation and four others are nearing completion, giving an aggregate capacity of 260,000 hp., the question of what shall be done with this development is still with us. A commission was appointed by the President to examine into and report to him upon the most practical method or methods of utilizing the Muscle Shoals facilities. This commission made a majority and a minority report. The majority report recommended leasing the property as a unit to private interests if satisfactory lessees can be obtained, and in the event of failure to obtain satisfactory leases within ninety days, that the government operate the plants. The minority recommended the leasing of the Wilson dam, the hydro-electric power generated there and the steam-electric power generating plant at Nitrate Plant No. 2 for a period not to exceed fifty years under certain conditions. It would have the power and fertilizer production leases separate and urged the appointment by the President of a Commission of five members to arrange for leasing the properties separately.

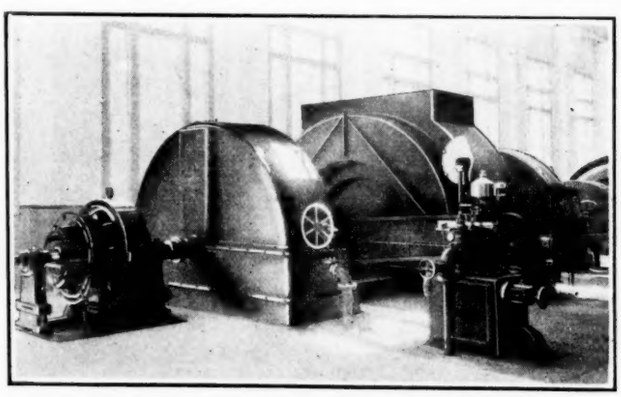
Although active interest continues in the proposed power developments on the Colorado, Columbia and St. Lawrence rivers, nothing definite in the way of real development has been started, principally because of conflicting interests among the states and provinces concerned. An enlarged joint engineering board is engaged on a further investigation of the St. Lawrence deep waterway and power project. A comprehensive program of boring and surveying in connection with the international section of the river, is under way. The British Privy Council has rendered a decision to the effect that the Provinces of Quebec and Ontario have control over the power developments on the St. Lawrence River. What effect this will have on this development is difficult to predict, since the Province of Quebec is against the deep waterway scheme, and the Province of Ontario is apparently anxious to go ahead with the power development.

Definite steps were taken during the year by the United States Geological Survey in co-operation with the American Engineering Standards Committee toward the formation of standards for rivers. Near the close of the year a questionnaire was distributed among those interested in this class of work, which will be used as a basis for such standards.

For a number of years the United States Army Engineers have been surveying the Tennessee River for navigation and for power developments. This work is progressed to where a hearing was held on Dec. 15 for preliminary permits for power developments on this river. The capacity represented by these permits totals 1,200,000 horsepower.

Among the interesting projects that went into commission on the Pacific Coast were the three 33,000-hp. reaction turbines in the Pit River No. 3 power house of the Pacific Gas & Electric Company. The power house is of novel arrangement in that the operating floor is at the turbine level and there are no intervening floors to interfere with the view of the units from the switchboard gallery. The units operate under an effective head of 280 ft., and when tested by the salt-velocity method, developed an efficiency of 93 per cent maximum, with all points of load from 18,800 hp. to full-gate opening, having an efficiency of over 90 per cent.

The Baker River Development of the Puget Sound Light & Power Co. consists of two double overhung horizontal-shaft Francis-type units rated at 20,000 hp.



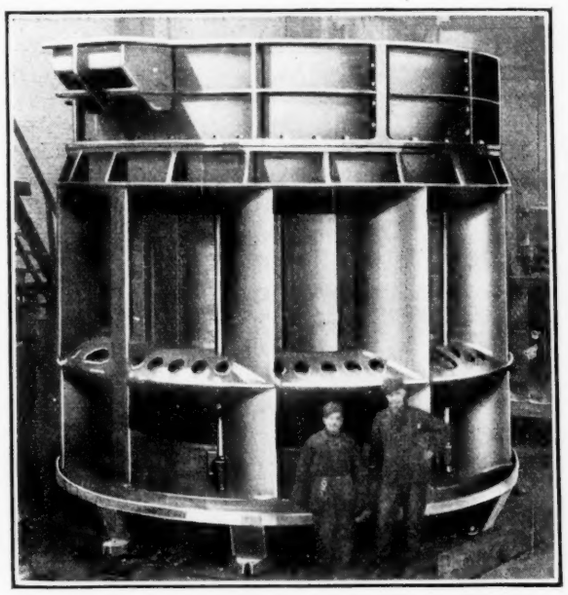
A 35,000-hp. unit operating under 1,900-ft. head (Big Creek No. 1 plant of Southern California Edison Co.)

operating under a head of 228 ft. These are the only two large machines of this type reported this year. When this plant is completed it will contain four units giving a total capacity of 80,000 hp.

In the field of impulse wheels the four 25,000-hp. units in the Moccasin Creek plant of the City of San Francisco were put into service. When this plant was first put into service, faulty operation of a penstock

valve by an inexperienced operator caused three of the penstocks to burst. These penstocks are nearly one mile long, and the effective head is 1,250 ft. Recently, a load of 50,000 kw. was instantly dropped at the plant with a resultant pressure rise of less than 15 per cent, showing that the regulating equipment, when properly handled, can give an excellent account of itself.

Two impulse wheels, one of 22,500 hp. capacity and the other of 35,000 hp., were put into operation at the Big Creek No. 1 and No. 2 plants of the Southern California Edison Co. The latter is the largest impulse wheel in operation in this country at the present time and operates under a 1,900-ft. head. These two wheels were put into service and were carrying 10 per cent overload within the record time of 48 hours after turning on the water.



Speed ring for 12,000-hp., ejector-type turbine

Upper row of openings admits water to the turbine, and lower row discharges water to the draft tube when the ejector gates are open. These gates can be seen back of the lower row of guide vanes.

In addition to the contract let for two 40,000-hp. impulse wheels to be installed in Brazil, already mentioned, there was a contract let for one 40,000-hp. double-overhang impulse wheel to operate under a 2,381-ft. head in the Balch Development on the King River of the San Joaquin Light & Power Co. This unit, when installed, will be the largest machine of its kind in this country. The penstock will be about 5,700 ft. long and the average velocity of the water about 11 ft. per sec. at full load. The inlet pipes to the wheels will be of cast steel 30 in. in diameter, about 2 in. thick and will be tested to a pressure of 1,655 lb. per sq.in. Each nozzle will develop 20,000 hp. and the jet will be about 7 in. in diameter and, where it leaves the nozzle, will be traveling at a velocity of about 370 ft. per sec., or 250 miles per hour.

One of the largest contracts for Francis-type wheels was that let by the Alabama Power Co. for three 45,000-hp. units, to two manufacturing companies. These units are to be installed in the Cherokee Bluffs Development to operate under a head of 145 ft. One of these units will be equipped with an air-inlet valve admitting air at the runner discharge during part-gate operation. It has been demonstrated on a number of large installations that material benefit is to be derived by admitting air to the draft tube during part-load operation.

A new unit was installed in the plant of the Cohoes Power Co. near Albany, N. Y. The settings for this unit had been installed a numbers of years ago and included an elbow-type draft tube intended for a 10,000-hp. unit. By a series of tests on models it was found possible to increase the capacity of the new unit 60 per cent and the efficiency 3.5 per cent. Considerable of this gain in power and efficiency was due to modifying the draft tube and indicates the advances that have been made in Francis turbines and in draft-tube design within recent years.

In the field of propeller-type units large gains in capacity were made. In this country and in Canada, there have been installed or now under contract 500,000 hp. of this class of turbines, ranging in size from 35,000-hp. units operating uuder a head of 65 ft. down to units of 100 hp., operating under heads of less than 10 ft. The Louisville Gas & Electric Co. let a contract to one manufacturer for eight of these units rated at 13,500 hp. each, to operate under a 37-ft. head. This is the largest contract for this type of unit ever let in this country and is exceeded only by that for four 34,000-hp. units, to two manufacturing companies, plant of the St. Maurice Power Company, Quebec.

For Francis turbines operating under high heads, the 35,000-hp. unit in the Oak Grove Plant still holds the record. The effective operating head on this unit is 860 ft. and the total static head is 920 ft.

Automatic hydro-electric plants have continued to grow, not only in favor but also in size. The largest plant to be put under automatic control is the Wallenpaupack Station of the Pennsylvania Water & Light Company. There will be two units rated at 28,500 hp. each, to operate under a head of 330 ft., and in addition to its other features it will be controlled by radio of the carrier current type. Another large station that went into service last year was the Soft Maple Plant of the Northern New York Utilities Company, which contains two 10,500-hp. units and is controlled automatically by closing the transmission-line oil switch in a substation about five miles away.

In high-head plants one of outstanding interest recently installed is that of the City of Colorado Springs, which is equipped with an impulse wheel of 1,100-hp. capacity, operating under 1,450 ft. effective head. It is started by remote push-button control, after which it automatically comes up to speed, is synchronized and takes on load to its full capacity.

Operations during the year have given strong support to the use of rubber seal rings for turbines and also the use of rubber for turbine guide bearings. The rubber seal rings at the Oak Grove plant turbine operating under 880 ft. effective head, have operated continuously for a year with the rings originally installed. On recent inspection the rings were found in good condition and with an existing clearance between rotating runner and stationary rubber rings of about 0.015 in. This indicates a wear for the year of about 0.010 in. and that the clearance existing between the rings at the present time after one year of operation is about what one would have to start in with as a fixed allowance had metal rings been used. The Pit No. 3 turbines of the Pacific Gas & Electric Company, at which plant are installed three 33,000-hp. vertical units, are fitted with rubber seal rings also. It is somewhat too early

to give any operating reports on these rings, as they have been running only five months.

Official tests were made on a number of plants during the year. Among these that information was available on is two of the 70,000-hp. units at Niagara Falls, which developed a maximum efficiency of 93.8 per cent, and over 90 per cent efficiency from 38,000 to 84,000 hp. load. A maximum efficiency of 93.8 per cent was also developed by unit No. 8 in the Queenston Station of the Hydro-Electric Commission of Ontario. These are probably the highest efficiencies of any turbines on record. Tests made on a 2,500-hp. propeller type unit, operating under a head of 30 ft., showed a maximum efficiency of 92 per cent.

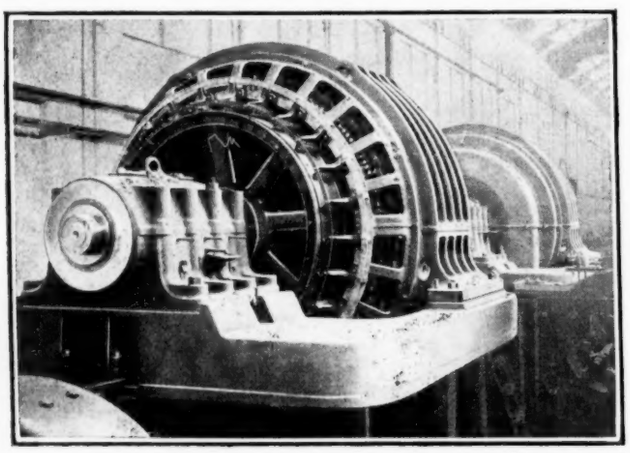
In Canada water-power developments during the last year have not been particularly active for new developments started. In point of capacity put into service the year was a record and amounted to 600,000 hp., 400,000 of which was in the Isle Maligne plant of the Quebec Development Company. In this station there are installed eight 50,000-hp. machines to operate under a 120-ft. head. All the work has been completed in the plant for four additional units up to the actual installing of the machines. The ninth 58,000-hp. unit was installed in the Queenston plant of the Hydro-Electric Power Commission of Ontario, at Niagara Falls. This unit completes this plant as originally laid out and makes it the largest installed in the world.

As to this year's business the prospect looks promising. Orders are about to be placed for three 90,000-hp. units to be installed in the Chute-a-Caron Development on the Saguenay River in Quebec. This project will eventually include twelve such units or, over 1,000,000 hp. in a single plant. The Provincial Government of Ontario has authorized the Hydro-Electric Power Commission to proceed with developments at five sites on the Ottawa River, these having a total capacity of 400,000 hp. Reports coming from other parts of the Dominion indicate new projects will be started or additions made to old ones.

No Radical Changes in Electrical Apparatus

Minor Improvements, Moderate Increase in Size of Units, Hydrogen as a Cooling Medium and New Types of Synchronous Motors Mark Progress During the Year

THE electrical industry has progressed so far that one would scarcely expect any radical changes in the brief period of twelve months. This is true in looking back over the year of 1925; there have been increased sizes of equipment, new methods of ventilating apparatus suggested, higher voltages adopted, etc.,



Two 7,000-hp. direct-current motors

but few of these possess the mark of a radical change over 1924. The capacity of waterwheel generators has not increased over that of a year ago in the 65,000 kva. at Niagara Falls. However, before another twelve months have elapsed, orders will probably be placed for considerably larger capacity units. The placing of a contract by the Brooklyn Edison Co., for an 80,000-kw. cross-compound turbo-alternator established a new record for this type of machine.

Using hydrogen as a cooling medium in large turbo-alternators was given considerable attention during the year, and if the experimental results can be duplicated in practice they promise the greatest advances in design of this class of equipment that have taken place since the development of the turbo-alternator. On account of the better thermal characteristics of hydrogen it will increase the capacity of a machine about 30 per cent over that obtained with air cooling and with the same temperature rise in the windings. The most serious objection to its use is the explosion hazard, but experiments have shown that this is not by any means so serious as was at first anticipated, and means can be easily provided to give satisfactory protection against this danger.

The results of increased sizes of equipment and power systems have caused radical changes in electrical manufacturers' facilities for producing and testing apparatus for these systems. One manufacturing company reports equipping a new high-power testing laboratory with two 20,000-kva. generators operating at 600 r.p.m. and driven by a 3,300-hp. motor. On short-circuit these generators in parallel will be capable of delivering a maximum current equivalent to 700,000 kva. three-phase. When testing a single pole of a circuit breaker on single phase, an initial current can be produced equivalent to more than 1,000,000 kva. on a three-phase system.

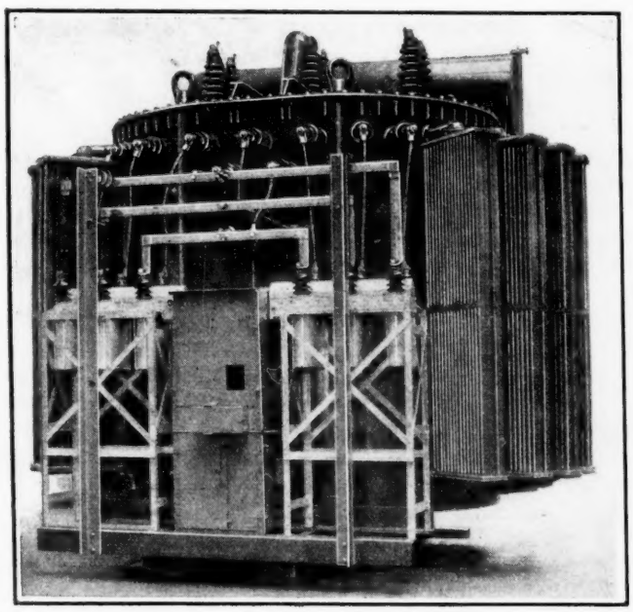
To transfer large blocks of power from one system to another, having different frequencies, frequency changers up to 35,000 kva. capacity have been built in previous years. Last year this limit was exceeded by a unit of 40,000 kva. A 40,000-kva. synchronous condenser was installed last year, which also establishes a record for this class of equipment.

In the application of alternating-current motors the use of synchronous motors continues to command an increasing amount of attention. Motors of this type are now available as standard machines in capacities down to 20 hp. In one type brought out last year the stator is made the internal part of the motor and is bolted directly to the frame of the driven machine. The rotor is supported on the shaft in such a way as to revolve about the stator. This greatly simplifies the construction of the motor in that it provides ample space for the poles on slow-speed machines, and it also makes possible placing all the necessary flywheel effect in the rotating element of the motor without the use of an additional flywheel.

Considerable attention is being given to simplifying the starting of synchronous motors, particularly by improving the torque characteristics of the motors so that they may be started by connecting directly across the line.

Although the ideal has not yet been accomplished in the design of synchronous motors, the fact that an order has recently been placed for a 9,000-hp. unity power factor 6,600-volt 25-cycle motor of this type for driving the main rolls in a steel mill indicates the confidence being placed in the performance of such machines. It is only within the last two or three years that engineers have had the temerity to consider synchronous motors for such applications.

This motor has a higher continuous rating than any motor so far applied to industrial purposes. The control is arranged so that full speed in either direction is

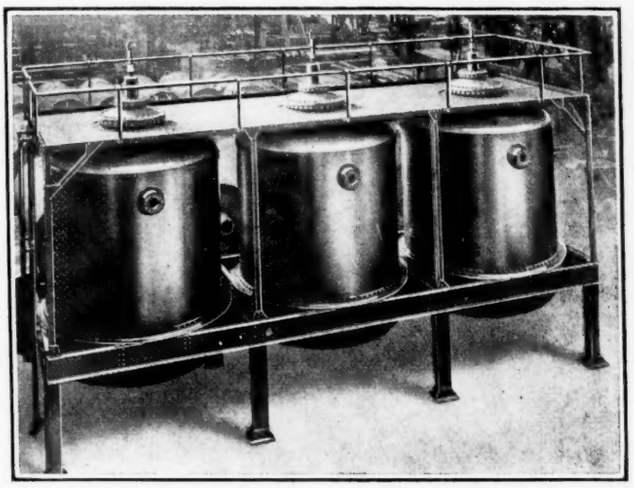


Auto-transformer rated at 36,000 kva. with ratio controller

obtained simply by throwing a master switch to the forward or reverse position. The complete operation of starting on the low-voltage taps of the auto-transformer, switching to a higher tap, applying field at the proper time, and throwing on the line is taken care of automatically.

Another company reports receiving orders during the last year for a 2,500-hp. synchronous motor for driving a steel tube mill. Also for two 600-hp. motors of the same type for driving rubber mills. The latter are specified to run for several minutes without excitation and develop full torque during this period.

Orders for direct-current motors rated at 7,000 hp. are reported by three different companies for driving reversing blooming mills, as well as orders for many large motors of the induction type for steel-mill drives.



One of two 32,000-kw., 13,000-volt electric steam generators

In a number of cases these motors replaced steam engines.

In transformers the maximum capacity for the self-cooled type, of 15,000 kva., was exceeded last year by two rated at 18,750 kva. These units were of the three-phase type and designed for 37,000 volts on the high-voltage side. An idea of the average size of power units is indicated by the report of one large electrical manufacturing company that the average size of all types of power transformers manufactured by it in 1925 was 4,175 kva. This is an increase of about 1,500 kva. over 1924.

For a number of years electrical manufacturers have been working on methods of changing the ratio of large transformers while under load; and last year saw a number of advances in the design of tap-changing equipment. A notable installation of an auto-transformer equipped with ratio control, without taking the transformer from service or interrupting the load, was installed at the Colfax Station of the Duquesne Light Company. It is of the self-cooled three-phase core type rated at 60 cycles, 36,000 kva., and acts as a tie between two 66,000 volt systems. This unit makes it possible to obtain a ten per cent buck or boost each in nine steps. Another notable auto-transformer is one rated at 66,667 kva. for use in connection with the 60,000-kw. three-phase 25-cycle turbo-alternator being built for the Buffalo General Electric Co.

In Canada electric steam boilers are continuing to be an important method of producing steam in certain industries located near large sources of cheap water power. One Canadian manufacturing company reports that it has built boilers of this type for a total normal capacity of 330,000 kw. The total capacity of this equipment installed in the United States, Canada and Newfoundland is approximately 600,000 kw. normal rating, but will carry up to about 50 per cent higher than this. One of the largest installations built during the year included three 28,000-kw. 6,600-volt units, and

two 32,000-kw. units for 13,000 volts, for a large Canadian paper company.

Although the electric steam boiler continues to increase in favor as a means of producing industrial steam from cheap water powers in districts where the cost of coal is high, and also as a means of absorbing excess water power, nevertheless the use of electricity for house heating in districts where it has been initiated is being discouraged. For example, the Hydro-Electric Power Commission of Ontario abandoned its sale of electric heaters and took steps to reduce to a minimum the heating of houses by electricity from its lines. The reason advanced for this is that these heaters put a heavy seasonal demand on the system during the winter months. To discourage this service the rates have been increased to where this use of electricity is almost prohibited.

It is also reported that the house-heating idea by electricity has been practically abandoned in Winnipeg; however, this has no bearing on the use of electric-steam boilers for supplying industrial steam under conditions similar to where they are now used, and their rapid growth in certain districts in Canada well justifies this condition.

Boiler and Auxiliary Patents of 1925

Patent-Office Records Reveal Trend in Boiler Designs—New Baffle Arrangements—Mercury Boiler Developments—Superheater and Accumulator Claims

By NATHANIEL FRUCHT
Assistant Examiner, United States Patent Office

ANY résumé of patented progress in steam generation necessarily must be condensed. No attempt will be made to set out more than the bare outlines of ideas expressed by selected patents that outline the paths of inventive progress in the past year. It should be noted that a considerable lapse of time occurs between the filing of an application for patent rights and the issue of the patent, and that many improvements are in use long before the patent appears.

European practice in adapting existing plants to high-pressure conditions is shown in Losel Patent No. 1,527,690, granted Feb. 24. He uses the old boiler layout as a low-pressure unit and installs a new high-pressure boiler, connecting the two by means of an intermediate accumulator in order to insure flexibility.

Ruths Patent No. 1,550,097, Aug. 18, improves on plants equipped with accumulators by imparting additional heat at a constant temperature to the steam withdrawn from the accumulator, thus obtaining superheated steam at practically constant temperature for use.

Simplifying the operation of high-pressure boilers by making the pressure of generated steam vary directly with the pressure of the feed to the boiler is shown in Ruths, No. 1,564,716, Dec. 8, and illustrated in Fig. 1. He accomplishes this by using a centrifugal feed pump running at constant speed and feeding into a coil boiler which absorbs heat from a separately heated heat-transmitting medium. If the heating medium is of sufficient capacity to evaporate the largest volume of feed required, the pressure of the generated steam will correspond to the pressure characteristic of the pump in relation to the pump discharge.

A new type boiler is disclosed by La Mont, No. 1,545,668, July 14, consisting of upright water tubes into the upper end of which water is forced tangentially under very high pressure in the form of a centrifugal spray, thus causing a downflowing film on the inside of the tube. The steam forms in the center of the tube and passes out at the lower end. Superheat is obtained by regulating the feed to limit the extent of the film along the tube length.

Increasing the flow area through the first bank of a B. & W. boiler in order to decrease the tendency for slag to collect on the lower tubes is the main idea in Jacobus No. 1,560,801, Nov. 10, who places his first bank along the roof of the furnace, thereby cooling the furnace gases and prolonging the life of the lining. This appears in Fig. 2.

Cotton, No. 1,536,776, May 5, splits the path of combustion gases in a Stirling type boiler into long and short flame passages in order to increase the heating surface.

Improvement in firebox construction of Scotch Marine boilers is obtained by Cotton, No. 1,540,106, June 2, who buckles the furnace walls into small lozenges by pressing in order to eliminate the usual rolling operation for forming expansion corrugations.

Crane, No. 1,558,344, Oct. 20, has an interesting baffle arrangement to prevent losses in draft due to reversal of flow of gases. He uses full baffles and provides openings therein for the gases to pass through, the openings being staggered in adjacent baffles to make the flow sinuous, and he increases the area of the openings toward the upper end of each baffle in order to equalize the flow through the baffle.

A mercury heater offers great difficulties in practice because the liquid spaces are necessarily small and the heat transfer must be rapid; the temperatures involved, moreover, are very high. Lowenstein, No. 1,533,706, April 14, explains the construction of boiler grids consisting of two thin sheets of metal slightly separated to form liquid and vapor spaces, the edges being sealed to provide an inlet and outlet. An interesting point brought out is that the generation of vapor is explosive when the liquid is confined in very narrow spaces and subjected to very high temperatures, with the result that any liquid particles in the vapor stream are completely atomized.

Improvements in grid formation to insure rapid circulation of the mercury and rapid circulation and good distribution of the flue gases are shown in Lowenstein, No. 1,551,411, August 25. Construction of grids to prevent leakage and at the same time permit the necessary expansion and contraction is shown in Emmett, No. 1,555,646, Sept. 29, who also uses spacing strips within the grids to divide the liquid into a large number of small streams for effective heating.

Coulson, No. 1,549,526, August 11, provides a boiler

that is practically all fire tube, the space between contacting fire tubes providing the mercury passageways, a few fire tubes being omitted at selected points to permit the insertion of mercury downcomer tubes.

Very little improvement has been made in electric boilers, the patents mostly relating to details of construction. Russell, No. 1,526,014, Feb. 10, discloses a method of regulation to maintain the power on the

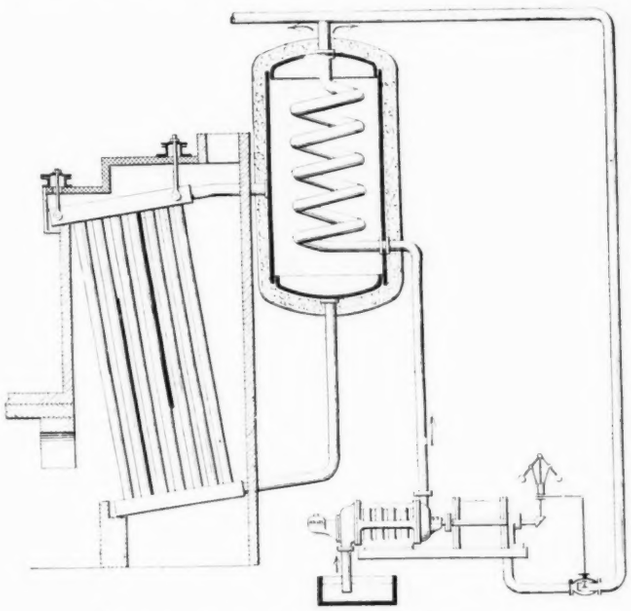


Fig. 1—Ruths boiler with feed-controlled steam pressure

transmission line constant. This is of particular interest in connection with the use of steam accumulators for constant load.

Three patents to Rauchfuss, Nos. 1,526,758, 1,526,759 and 1,526,760, Feb. 17, show a vertical boiler in which the electrodes are placed within open-ended tubular members of insulating material, both the electrodes and the tubes being movable.

Otis, in two patents, Nos. 1,543,514, June 23, and 1,550,224, August 18, has a special form of electrode for a three-phase boiler, and special electrode chambers, to provide means for loading the electrode surfaces relatively lightly.

Munzinger, No. 1,558,997, Oct. 27, controls the boiler feed by both the pressure and water level, in order to limit feeding whenever the steam demand becomes excessive. He accomplishes this both by substitution of pressure for float control and by raising and lowering the range within which the float control operates, depending on the pressure conditions.

A similar device is disclosed in Ruths, No. 1,522,082, Jan. 6, for use in steam accumulators, and another variation of the same idea applied to a water heater is shown in Still, No. 1,549,033, August 11, who also provides a fuel control for varying the fuel supply inversely to the water supply when an unusually large amount of heated water is drawn off.

Milker, No. 1,563,097, Nov. 24, corrects the effects of varying steam and water conditions on a thermostatic water control by providing a compensating device.

Automatic means for removing air from boiler feed is shown by Broido, No. 1,560,754, Nov. 10, shown in Fig. 3, who heats the feed and pumps it into an elevated tank *A* for supplying the usual boiler-feed pump *B*; the air is permitted to accumulate in the elevated tank and is then forced out through an air vent *C* by boiler water admitted under boiler pressure through *D*, the boiler water being cut off as soon as the air is eliminated.

Bell, No. 1,565,304, Dec. 15, calls attention to the use of the Foster-type tube for an economizer and the resulting increase in capacity due to the unusually large amount of heating surface per unit volume of space occupied. Bell, No. 1,565,304, Dec. 15, arranges for washing this type of economizer by downwardly directed sprays, the corrugations on the tubes preventing longitudinal flow and insuring thorough cleaning.

The throttling of flue gases by economizer headers is prevented by Munzinger, No. 1,538,256, May 19, who staggers adjacent headers to afford free gas passages. Carbery, No. 1,554,258, Sept. 22, installs a feed heater in locomotives in place of the usual smokestack and petticoat pipe, and also inserts an exhaust-steam coil within so that the feed is heated by both exhaust gases and exhaust steam.

Sullivan, No. 1,563,938, Dec. 1, arranges water baffles in a B. & W. boiler so that the water circulates

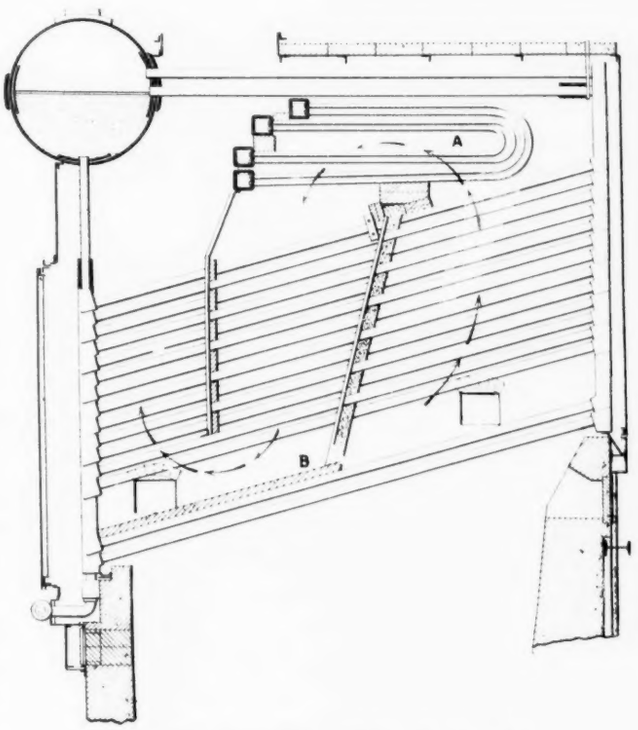


Fig. 2—Jacobus system of baffling

in a closed path, one portion of the path passing through a surface feed heater; the baffle water therefore continuously circulates and acts as an indirect heating medium for the feed.

Superheaters

Bell, No. 1,541,205, June 9, has a separately fired superheater which, as shown in Fig. 4, comprises two portions in series, the first portion exposed to radiant heat of the furnace, in order to lower the flue-gas temperature, and the second portion exposed to convection heat.

Maintaining constant superheat by automatic control

of dampers is shown in Vennum, No. 1,552,020, Sept. 1, who installs his superheater tubes in front of the rear tubes of a Vennum single-pass boiler, arranging damper bypasses between superheater sections so that the furnace gases either pass through the superheater and rear tubes, or else bypass the superheater to reach

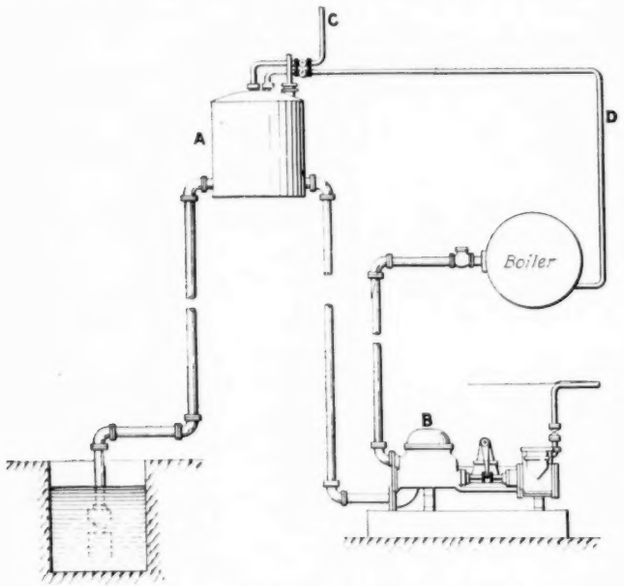


Fig. 3—Broido's deaërating apparatus

the rear tubes. The use of decreasing flow area through the rear tubes is worthy of note.

Speyer, No. 1,561,574, Nov. 17, has the banks of a B. & W. boiler spaced apart to form a heating chamber in which two heating devices, such as a superheater and a reheater, are placed; a movable baffle is arranged to regulate the amount of gases passing over one of the heating devices, the other always being exposed to all the furnace gases.

Safety means for superheater tubes are provided in Broido, No. 1,560,755, Nov. 10, who divides the steam space of a boiler into two sections and interconnects a fire-tube superheater so that closing the outlet valve will cause steam to flow from one section to the other through the superheater tubes, thus insuring continual steam flow in the tubes.

Superheater for Process Steam

An interesting use of superheated steam is shown in Broido, No. 1,564,403, Dec. 8, who finds that circulating steam through heating tubes at a velocity above a certain critical value prevents condensation on the walls of the tubes and enables the superheated steam to be used at higher temperatures than the saturation temperature of the steam, for drying ovens, enameling ovens, etc.

Wilson, No. 1,547,708, July 28, regulates blowoff and eliminates hammer in high-pressure boilers by blowing off into a closed tank against a cushion of gas under pressure. This method also permits him to obtain small samples of boiler water for analysis.

The use of fan-shaped sections for the noses of furnace arches, taught first by Strachota, No. 1,506,458, issued in 1924, and British patent No. 190,397, has brought forth many improvements in the shape of the sections and their supporting means, such as shown, for example, in Stevens, No. 1,544,867, July 7.

Few advances in wall construction have followed the French patent No. 585,032, which showed the idea of stringing furnace bricks on supporting members like beads on a cord, without cementing, thus providing for quick replacement. Packard, No. 1,553,004, Sept. 8, shows a wall in which vertical water tubes are inclosed by the refractory blocks, thus cooling the walls and heating the tubes by convection. It is interesting to note that British patent No. 22,643, Oct. 2, 1897, shows a furnace completely surrounded by water walls.

No important changes in pulverized-fuel installations have appeared since Kreisinger, No. 1,510,994, issued in 1924, preheated his combustion air in separate horizontal layers around the furnace and regulated the admission from each layer. Leach, No. 1,552,438, Sept. 8, improves a pulverized-fuel nozzle in order to obtain a fan-shaped spray.

Air Preheaters

The changes in air preheaters are mostly improvements over Ljungstrum, No. 1,516,108, issued in 1924, who substituted a rotating checkerwork barrel for the previous regenerative systems, the air and combustion gases flowing continuously in the same paths. Andersson, No. 1,547,549, July 28, assigned to the Ljungstrum Co., of Sweden, places this preheater in a more advantageous position between the ashpit and the lower part of the chimney; and Ljungstrum, No. 1,558,445, Oct. 20, adds a cleaning means for removing soot.

Prat, No. 1,559,180, Oct. 27, provides a simple means for constructing an air preheater of plates, channel irons and resilient spirals, the spirals holding the plates apart against two of the channels to form passages for the air, the other channels being placed between the unobstructed edges of adjacent elements to form

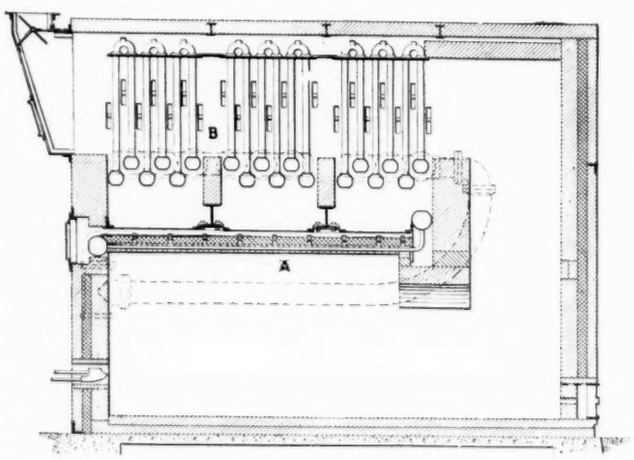


Fig. 4—Double superheater patented by Bell

passages for the combustion gases at right angles to the air passages.

The general line of advance in chain stokers seems to be in improving the control of combustion. Duncan, No. 1,522,812, Jan. 6, reduces the side draft to compensate for radiation from the walls; Atkinson, No. 1,541,613, June 16, keeps the fuel in constant agitation; Strong, No. 1,535,961, April 28, stops leakage in multiple-draft-box systems so as to maintain accurate regulation, and Pfleiderer, No. 1,548,550, Aug. 4, provides a water-cooled oscillating rake for keeping the

fuel bed level. Duncan, No. 1,516,339, issued in 1924, should be noted as providing for reduction and ultimate stoppage of draft in a multiple-draft-box system whenever the fuel bed burns through.

The line in underfeed stokers follows closely to that of chain stokers. Diplock, No. 1,540,546, June 2, improves the regulation of air, and Skelly, No. 1,522,917, Jan. 6, controls the variation of air at different points of the fuel bed. Ratel, Nos. 1,539,208, May 26, and 1,539,369, May 26, agitate the fuel continuously; Foresman, No. 1,539,252, May 26, provides air cooling for tuyeres. So far as improvements in rams are concerned, no real advance has been made since British patent No. 185,606 taught the idea of toggle-joint operation, the toggle giving way whenever the ram clogs or the load exceeds a certain predetermined value. Schwendner, No. 1,548,065, Aug. 4, provides for simultaneous adjustment of the stroke of a battery of feeding rams during operation.

[*Copies of U. S. patents may be obtained by writing to the Chief Clerk, U. S. Patent Office, Washington, D. C., and inclosing ten cents for each copy desired; photostats of foreign patents cited will be supplied for fifteen cents per sheet.—Editor.*]

Engineering Research and Society Activities

TO ILLUSTRATE the importance now being attached to engineering research and the means available, attention need but be called to the appointment by the Engineering Foundation on or about the first of the year, of 190 leading engineers in twenty-seven cities as local representatives. It is the plan that these engineers, representing industry, education and the public service, will help the Foundation Board in a nation-wide plan for the furtherance of research in science and engineering and for the advancement of the profession of engineering.

Another favorable indication for the advancement of research was the regrouping during the year of several government agencies, including the Bureau of Mines, to create in the Department of Commerce a division embracing the activities of the government's scientific and economic research in aid of industry.

Of particular interest to the power-plant field is the investigation instituted by C. F. Hirshfeld and now being carried out by the Bureau of Mines in co-operation with eighteen central station companies to determine what can be done toward the solution of the problems encountered in connection with boiler-furnace refractories. As publicity during the year has indicated, encouraging progress has been made. An interesting development in the field during the year was the formation of the American Refractories Institute, which held its first meeting in March at the Mellon Institute of Industrial Research in Pittsburgh.

Other work of a leading character is the research on metals at extreme temperatures being conducted by a joint committee of the American Society of Testing Materials and the American Society of Mechanical Engineers, including the standardization of procedure for testing materials at high and low temperatures and the outlining and fostering of new research work in this field.

A most interesting development is the use of the X-ray for testing the soundness of materials and the location and character of flaws without recourse to the usual method of testing to destruction. This is proving of great value in the examination of the heavy steel castings for advanced steam conditions. At the Watertown Arsenal the government has been obtaining some remarkable results and is being petitioned to increase its facilities.

Perhaps no subject in the power-plant field is in greater need of comprehensive survey than that of boiler-feed water. Engineers generally will welcome the exhaustive study of this subject instigated by the American Water Works Association. The work is being conducted by an advisory committee and eight subcommittees in which the National Electric Light Association, American Society of Mechanical Engineers and the American Railway Engineers Association are represented. Nearly one hundred engineers from the four societies mentioned are at work, and the program they have been assigned may require years to cover.

Commercial interest in high steam pressures and temperatures has grown so rapidly, that the accumulation of scientific data has lagged behind the immediate needs of the designers, particularly in the high ranges, where published tables of steam properties are little more than good guesses. This condition, however, will soon be rectified, as good progress is being made in this country in the extensive program of steam research that has been under way for some time at Harvard, Massachusetts Institute of Technology and the Bureau of Standards. Backed by the Research Association in England, Professor Callendar is supplementing this work by investigation of the specific heat of superheated steam at high pressures and temperatures. Knoblauch and other European investigators have completed recently some work of high quality, so that these numerous independent investigations, by affording means for cross-checking, should eliminate the possibility of any serious error in the final published results.

Petroleum research is to be aided by a fund of $250,000 pledged by John D. Rockefeller to the American Petroleum Institute.

Of the various activities of engineering associations that should leave their impress on future generations and prove of inestimable value to industry and the future engineer, mention should be made of the far-reaching investigation on engineering education in its every aspect that is being sponsored by the Society for the Promotion of Engineering Education. Backed by an appropriation of more than one hundred thousand dollars from the Carnegie Foundation and with the co-operation of the national engineering societies and more than a hundred educational institutions, much interesting information has been brought to light. The Engineering Council has been active in questions of national import. In its 1925 edition on tentative stand-

ards the American Society of Testing Materials presents 193 standards on a wide variety of materials.

At the beginning of the year announcement was made that the American Society of Mechanical Engineers had in the course of preparation twenty codes. During the year several of them appeared in final pamphlet form, so that eight are now available, with two undergoing a new revision. Three or four more are close to final acceptance and should be issued in pamphlet form within a few months. These codes, in common with others of recent date, have been rewritten entirely and prepared independently of the 1915 versions, suggested rules for the care of power boilers as an addition to the construction code have been given publicity in tentative form, good progress is being made on the other codes, and in addition the Society has accepted membership on the United States national committee of the International Electrochemical Commission, which has undertaken the development of a series of international standards and codes for acceptance tests on the various types of prime movers.

The fuels division of the society, in co-operation with the American Society of Heating and Ventilating Engineers, the Stoker Manufacturers Association and the American Civic Society, has been carrying on an active campaign in the interests of smoke abatement. In this connection mention should be made of the passage of a smoke ordinance by the City of Detroit and the establishment of a smoke-prevention bureau.

During the year impetus has been given to the movement initiated in 1924 to establish and maintain a permanent organization and a home for commemorating the achievements and perpetuating the records of engineering and industry. The new home is to be called the National Museum of Engineering and Industry. It will be under the direction of the Smithsonian Institution at Washington, D. C., and provision will be made for local and smaller branches in the larger cities, where replicas of the fundamental mechanical principles from all sections of the world will be placed for the convenience of students and workers.

Although not on so large a scale as planned at the offset in 1920, the Sesqui-Centennial International Exhibition has been definitely scheduled to be held in Philadelphia from June 1 to December 1, 1926. It will commemorate the one hundred and fiftieth anniversary of the signing of the Declaration of Independence, and the original thought was to make it worthy of the event and in engineering interest rival the Centennial of 1876.

Honor Roll for 1925

One of the highest awards of the engineering profession, the John Fritz Medal, was presented early in the year to John Frank Stevens for his great achievements as a civil engineer, particularly in planning and organizing for the construction of the Panama Canal, as a builder of railroads and his successful administration of the Chinese Eastern Railway during the war.

In recognition of his achievements in the field of steam-turbine design and construction during the last thirty-one years, Francis Hodgkinson was awarded the Elliott Cresson gold medal conferred by the Franklin Institute.

The 1925 Edison Medal has been awarded to Harris J. Ryan by the American Institute of Electrical Engineers for his contributions to high-voltage transmission of power. Upon his development of a new thermometer of fused quartz using metallic gallium to replace mercury, which will indicate heat twice as great as can be measured by the best mercury thermometer, E. R. Berry, assistant director of the Thomson Research Laboratory of the General Electric Company, was the recipient of the Grasselli medal conferred by the American section of the Society of Chemical Industry.

From the American Society of Mechanical Engineers the Charles T. Main awards went to Clement R. Brown, the junior award to Gilbert S. Schaller and the student awards to E. Ray Enders, Jr., William S. Montgomery, Jr., and Harry Pease Cox, Jr. Wide interest was taken in the power essay contest of Bonbright & Company, public utility bankers. It will be recalled that $10,000 in prizes was offered for the best combined review and forecast of the electric light and power industry for the decade 1920 to 1930. The first prize of $5,000 went to David Cowan of Montreal and the second prize to R. M. Davis, Statistical Editor of *Electrical World*.

During the year four new annual awards were created by James H. McGraw, of the McGraw-Hill Company, Inc., to encourage individual initiative and creative thinking among electrical men.

Tribute came to Herbert Hoover and to W. R. Warner in the form of honorary memberships in the American Society of Mechanical Engineers. In recognition of his great service to the Boiler Code Committee, as its active chairman for fourteen years, John A. Stevens received a fitting testimonial from the Council of the Society.

In England Sir J. J. Thompson was awarded the Faraday Medal by the Council of the Institution of Electrical Engineers. This medal is given for notable achievement in electrical engineering or for conspicuous service in electric science. Another engineer of note receiving honor in his own country is Johannes Ruths who was tendered the gold medal of the Royal Institute of Scientific Research of Sweden for his work on the steam accumulator. The triennial prize of 4,000 francs of the Foundation George Montefiore, of Liege, Belgium, for the year 1925 went to Dr. J. B. Whitehead, professor of electrical engineering and dean of the faculty of engineering of Johns Hopkins University.

Honor of leadership in the various societies and associations closely allied to Power's field was conferred by the following presidential selections:

Society	President
American Engineering Council	James Hartness
Engineering Foundation	Lewis Buckley Stillwell
American Society of Mechanical Engineers	W. L. Abbott
American Institute of Electrical Engineers	Dr. Michael I. Pupin
Association of Iron & Steel Electrical Engineers	G. H. Schaeffer
American Society of Refrigerating Engineers	L. H. Jenks
American Society of Heating & Ventilating Engrs.	Prof. S. E. Dibble
American Boiler Manufacturers Association	George S. Bach
National Electric Light Association	James E. Davidson
National Association of Stationary Engineers	Garrett Burgess
National Association of Practical Refrigerating Engineers	Charles W. Chapman
National District Heating Association	Earle Schultz
Stoker Manufacturers Association	J. V. Santry
Smoke Prevention Association	W. R. Supple

For assistance in gathering material for this review the Power editors are especially indebted to H. W. Brooks for suggestions on the fuels section and to the following manufacturers for information on developments in special lines: Allis-Chalmers Mfg. Co.; General Electric Co.; Westinghouse Electric & Manufacturing Co.; Fuller-Lehigh Co., and American Engineering Company. Other engineers and companies offered helpful suggestions.

Looking Ahead

ALL things considered, conditions in the power plant field have been very satisfactory during the year just past, and the prospects for 1926 are most promising. Inasmuch as the program laid down two or three years ago for the construction of a number of large base-load stations is rapidly nearing completion, a greater proportion of the central station expenditure this year will be for interconnection and distribution. Still there are a few large stations to be constructed during the year and many of those placed in service during the last two years are now being enlarged in order to keep pace with the demand for electrical energy.

The industrial power plant field promises greater activity than for some years past. This applies more particularly to the large plants employing steam for process work. Profiting by the experience of central-station engineers in development work, many of the industrial engineers and executives have set about remodeling their plants and are adopting high steam pressures, pulverized coal, bleeder heating and other refinements.

The annual review which appears in this issue reflects detailed developments in various branches of the field, all of which seem aimed at the attainment of greater economy in the generation of power. Much has been accomplished during the last five years, as comparative figures will show. Each additional gain in economy is likely to be accomplished at increased cost. Yet the struggle continues. It is the inspiration and goal of the engineer.

The Combined Diesel and Gas Turbine

WHY so large a machine for so little power, is the question that is asked by the layman upon first viewing a high-compression oil engine. The engineer may overwhelm him with arguments on strength of materials, factor of safety, use factor and all the other problems confronting the design. Still there is no real answer to the query, Why so much cast iron?

The appearance of the double-acting four-stroke-cycle and two-stroke-cycle Diesels is proof that engineers realize the weight disadvantage, which is, of course, reflected in a high manufacturing cost. Still the weight per brake horsepower appears too high. The plan of supercharging or loading the working cylinder with more than the normal weight of air has been used with some success. However, the increased consumption of oil gives a lower thermal efficiency, and the gain in horsepower cannot be great without a marked thermal loss.

It has been proposed by a Swiss engineer, that the Diesel be used as the high-pressure cylinder of a compound unit, the low-pressure element being a gas turbine. The engine is to be supercharged from a blower driven by the engine shaft, and the amount of oil burned is such that the expansion at the time the exhaust valve or port opens, will not cause a pressure drop of more than fifty per cent. The burnt gases are to pass through the vanes of a gas turbine and discharge at about atmospheric pressure. Experiments have been run on an engine and turbine connected in this way, with gratifying success.

On the surface the plan has merits. The Diesel is built to withstand high pressures, and with this design the pressures would be high over the entire cycle rather than over a small portion as at present. The temperature of the exhaust gases would be higher than the exhaust temperature of a normal Diesel, but not too high for modern metallurgy to conquer. That the capacity per pound of metal would be double that possible with present designs seems within reason.

Lower First Costs For Turbine Room

RECENT studies of the production cost of steam power have shown that the fixed charges per unit of output have been increasing for a period of years while fuel costs and labor have as a whole been decreasing. Designers have naturally given much attention of late to studies of station first costs and to means whereby these can be lowered.

Several plans have been proposed that will tend to lessen boiler-house cost. These are being considered.

It has also been pointed out that increased capacity may be secured from standard turbine designs at small additional cost by multiple bleeding and by the use of hydrogen as a cooling medium in the generator, thus effecting some reduction in unit first cost.

Any engineer who has visited one of the new large central stations cannot fail to be impressed with the large volume of the turbine room that is unoccupied and seems to serve no purpose during normal operation. The turbine itself towers on expensive foundations thirty or forty feet above the basement floor. Space must be left above the turbine for lifting the cover and the spindle. Building cost is a large element in first cost and is closely related to the volume inclosed. Hence any reduction of turbine room over-all height would reduce volume and first cost.

Is all this volume absolutely necessary? It has long been the practice to place the condenser below the turbine. There is no thermodynamic advantage in this arrangement, and its use must be based on certain structural features and on custom. Suppose vertical condensers were used and the turbine exhaust were taken out the side or top of the turbine casing as in marine practice. Then the only foundation needed under the turbine would be sufficient height to provide for drips and small piping and possibly for generator air coolers, though even these might be placed at the

side. This would reduce turbine foundations to six or eight feet, and monolithic concrete could be used. The condenser tubes would be drawn vertically, and this necessary clearance would probably fix roof heights. It might be possible to make the turbine room narrower, as no horizontal clearance for drawing condenser tubes would have to be provided. Careful design would be needed to arrange all the necessary auxiliaries in the smaller floor space, but this could be done or some could be placed elsewhere. These auxiliaries would be accessible from the turbine platform, and this would simplify operation.

Such an arrangement of turbine room would undoubtedly reduce volume and would seem to be a logical move in further reducing first costs and fixed charges.

The Roots of Progress

DIVIDENDS paid by research properly organized and directed have so generally exceeded those obtainable by equal expenditures in other fields that many of America's largest and most substantial industrial organizations have accepted large-scale research as an essential to commercial success. The General Electric Company, American Telephone & Telegraph Company and Eastman Kodak Company are outstanding exponents and practitioners of this policy.

Great organizations like those named can afford to spend enormous sums on research. For example, the American "Tel and Tel" (with its subsidiaries) employs over 3,500 scientists and technicians in its research laboratories. Industries made up of smaller units have in many cases established co-operative research laboratories, most of which are doing excellent work. Practically every large university and engineering school is making substantial contributions to scientific knowledge. Outstanding examples are the University of Illinois Engineering Experiment Station, the Mellon Institute of Industrial Research (University of Pittsburgh) and the Massachusetts Institute of Technology.

Much of this research work is what might be termed "commercial" in that it seeks information of immediate dollars-and-cents value. There is, however, a large and increasing volume of fundamental "pure-science" research. This is the sort of work that is being carried on in the chemical, physical and biological laboratories of the universities by men who work largely for the love of the game. A few of the large industrial laboratories also encourage fundamental research. In some cases this has progressed to the point of giving the research organization practically a free hand in selecting the problems to be studied. Modern history shows conclusively that fundamental research generally undertaken with no definite practical aim in view has, in the long run, produced even more wealth than the so-called "commercial" research, immensely profitable as that is.

The discoveries of a single non-commercial scientist —Faraday—have, in the electric motor, generator, telephone, transformer and a thousand other later applications, created wealth far exceeding the cost of the whole world's research from his day to this.

Tremendously important as this pure-science research is, the fact that its practical results are sometimes a little slow in appearing and that the benefit is spread over the whole population, militates against proper support. Real scientists work mainly for the love of the job, but they must have books and apparatus, and their families must be supplied with food and clothing.

For the future health, wealth and prosperity of the nation some method must be found of greatly increasing the number of gifted workers in pure science and of supplying them with adequate facilities and such salaries as will remove financial worries. In the offing are new Faradays, Curés, Hertzes and Regnaults who need only a little encouragement to lay the foundations for a new industrial order as far ahead of this as this is ahead of the Middle Ages.

Plan Now for Next Summer

WITH the opening of the new year it is natural to take stock of one's situation and lay plans for the future. The time is especially appropriate for the power-plant operating engineer. The winter season is well under way. Some plants have already passed their peak load, and yet there remain several months before the summer affords opportunity for overhauling and rebuilding the plant and equipment. There is time to study plant needs and to develop a well-rounded program of maintenance and improvement.

In order that the summer's work may be well done, complete records are essential, and if they are properly systematized, the work will be done more easily and certainly. It is irritating, to say the least, to put an engine or boiler into service after an extensive overhauling, only to find that some little but annoying defect has been forgotten.

There are many schemes for keeping track of things that need to be done. Perhaps the simplest is to mark a handful of envelopes, one for each piece of equipment in the plant and whenever the need for any bit of work, large or small, is noticed, jot it down and put the slip in the corresponding envelope. In some cases it may be preferable to group jobs by the kind of work rather than by equipment; for example, it may be convenient to have an envelope for all pipefitting jobs.

Meanwhile, the engineer in charge should occasionally go over this growing accumulation of jobs, discussing them with his subordinates, and thus develop an orderly, complete program to lay before his management. This should be accompanied by a complete bill of material, an estimate of labor requirements, and perhaps by a detailed statement of expected cost.

Such a procedure will command the respect of the management. It avoids the helter-skelter methods of the engineer who is constantly seeking authorization for repairs, often for the same equipment.

Such evidence of lack of a comprehensive plan undermines confidence and promotes a feeling of uncertainty. The owner wonders whether, after all, the plant will be in shape to operate properly.

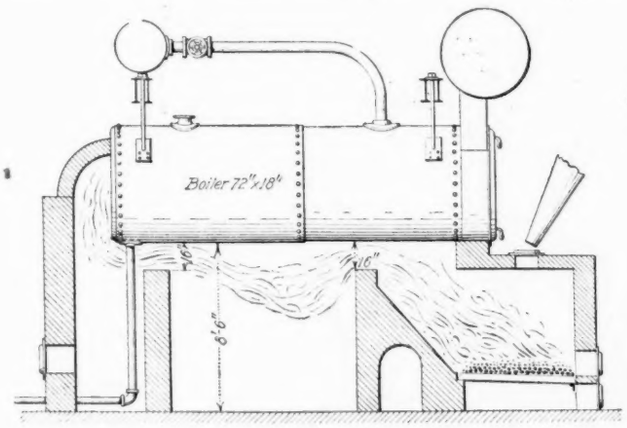
Of course, unforeseen necessities arise. When a machine is torn down or when a boiler is opened, unsuspected conditions are disclosed. Such things can be covered in estimates only by more or less uncertain allowances for unknown contingencies.

An important advantage of beginning now to plan for work to be done during the summer is the time available for the study of the more difficult problems. Does equipment fail in the same way time after time? It should not simply be rebuilt, but an effort should be made to study its operation and determine whether it can be improved. When the experience of the men on the job falls short, let them call upon others.

Practical Ideas From Practical Men

Protecting Blowoff Lines

I am anxious to have the opinion of other engineers on the plan of protecting blowoff lines as shown in the illustration. The setting was designed for the burning



Blowoff Protecting Wall

of sawdust and wood waste. Each of the three boilers in the battery has its own furnace, but the combustion chamber is common to all three.

The fire wall in front of the blowoff pipe extends clear across the combustion chamber.

Libbey, Mont. FRANK E. BALIMAN.

Buckling of Boiler Tubes

What causes boiler tubes to buckle? Why, that's easy—unequal expansion under the influence of intense heat. But what causes the unequal expansion?

Heat alone cannot cause unequal expansion of metal. Clean boilers, with clean tubes, will take care of all the heat that comes their way without undue stress. But heat combined with scale will and does cause unequal expansion, and in fact buckling seldom occurs except in the presence of scale.

An enlightening fact is that buckling is always in the direction of least resistance. In water-tube boilers of the horizontal type the bulk of the scale deposits on the lower side of the tubes. Therefore the tubes buckle upward. In fire tubes the scale of course settles on the upper side of the tubes. Therefore buckling is always downward.

Buckling of the tubes is not the only indication that scale is or has been neglected. Other signs are burnouts, weak tubes and in time tube failures. In fire-tube boilers the tubes frequently loosen in the headers, causing leaks. Expanding follows but the leak recurs. New tube ends are welded on. Then come more leaks, more tube failures, retubing and shutdowns. Scaly boiler tubes, especially in a return-tubular boiler, may appear to be sound while if the scale was removed from the tubes they would be found defective.

It is worth emphasizing that the commonest cause of weak, leaky, buckled or loosened boiler tubes is scale. In this connection it is interesting to go through the reports issued by the boiler inspectors of the various insurance companies, covering the causes of defects in boiler tubes. These reports show that more than 50 per cent of these defects are directly attributable to scale. Recurring leaks are sure signs of scale, and the leaks will continue as long as the scale is neglected. On the other hand, once scale is removed from the tubes and kept out by regular and periodical cleaning thereafter, tube failures will be a rare occurrence.

Buffalo, N. Y. W. HARRIS DAY.

One Power Plant for a Number of Industries Would Prove Economical

If several industries of widely diversified types were grouped closely together, say within a circle with a radius of a half mile or less, and supplied with power and heat from a common power plant, the resulting cost reduction would be well worth while, and there are manufacturing districts of this description in various parts of the country. Whether the necessary co-operation could be secured from the parties concerned is another side of the question.

I once worked in a plant where the power cost was thought to be the lowest possible, since all the exhaust from the engines was utilized the year round and apparently there was no advantage to be gained from installing prime movers of better thermal efficiency. Several engines of the single-valve type and one large four-valve engine totaling 1,500 hp. operated at 130 lb. initial and 8 to 12 lb. back pressure, and the total steam output was from 48,000 to 55,000 lb. per hour on the day shift and about half this amount on the night shift. Within a quarter of a mile were several small industries, including machine shops, steel stamping and press shops, whose power cost was probably high on account of their small individual power consumption of approximately 150 to 200 hp. each. No condensing water being available at a reasonable price, these small plants operated non-condensing or else purchased their power at rate of 2 cents or above. In the latter case they heated with live steam in winter, and in the former case exhaust heating was possible, while the exhaust in summer wasted to the atmosphere. The steam rate of these small engines can be placed at 22 to 35 lb. per hp.-hr., depending of course on the type of engine. As the boiler pressure in many of these plants is below 100 lb., the actual steam rate would be above and not under these figures.

Now when we stop to consider that unaflow engines have attained steam rates of 14 lb. per hp.-hr. non-condensing, it is easy to see that there is considerable room for improvement in the performance of the plants mentioned. Assuming the average steam flow in the first plant to be 50,000 lb. per hour on the day shift,

the power output from unaflow engines supplied with steam at 300 lb. pressure and a fair degree of superheat, would be around 3,570 hp., or 138 per cent above the power requirements of this plant. This excess of 2,070 hp. could supply several smaller plants in the vicinity without increasing the fuel consumption of the plant by more than 5 per cent. And if the plant operated in parallel with the public-service company, still more current could be generated in winter and exhaust steam could be supplied from a central point. If interconnection with the power company is not feasible, one condensing unit would have to be operated in summer to take care of such emergencies as maximum power demand at the same instant that minimum process steam demand occurs.

This idea could be profitably applied to industries with a 24-hour load, but the return on the initial investment would be less where the plants operated only one shift of eight or nine hours a day.

I lived in one city in this state where a large state institution burned 25 tons of coal daily in winter for heating buildings alone, and their average power demand did not exceed 150 kw. at any time. The fuel rate of over a ton an hour or a steam flow of 17,000 lb. per hour meant that for every kilowatt-hour generated there was over 113 lb. of steam used for heating. With a high-pressure plant, as herein described, at least five times this amount of energy could be generated, and there are enough near-by industries to furnish a market for this excess power. There are some plants in the vicinity where the power requirements so far exceed the heating requirements that condensing engines are operated in winter. If they used the excess energy referred to, 600 kw., or 14,400 kw.-hr. daily, the fuel saving is around 28,800 lb. daily. Of course this saving would be made only in winter, as the steam demand in the institution is small in summer. The maximum saving appears to be around 2,100 tons annually, and possibly on such a small scale the total fuel saving would not leave a very large margin above the fixed charges on the plant and transmission lines.

I am not prepared to state that the second case would be a paying proposition, but it compares favorably with two automatic hydro-electric plants of about 500 kw. each, which were developed recently at a cost of nearly $200 per kw. of capacity, in which, owing to irregularities of steam flow the average output is not over 250 kw. each. The owners of these two plants are considered to have employed the best engineering talent in the enterprise. The cost of a high-pressure steam plant would not be over 40 per cent of the cost of the hydro stations mentioned. ANDREW F. SHEEHAN.

Brightwood, Mass.

How Should a Watch Engineer Spend His Time While on Duty?

There are many ways for a watch engineer to spend his time while on duty. For instance, he can keep himself busy by "talking politics," telling stories or discussing things that do not pertain to his work, trusting that good luck will favor him in taking care of his responsibilities. A better way is to constantly consider the most economical operation of the plant as a whole. After he has ascertained which machines are in operation and has satisfied himself as to the operative condition of the equipment, he can pay considerable attention to other details such as cleanliness of the machines, adjustments, etc.

Some time should be spent in watching operations at different points throughout the plant, especially in the boiler room, where different conditions exist almost daily and the efficient handling of them is of primary importance. As we all know, the greatest saving in the operation of a power plant can be effected in the boiler room.

It is important that the watch engineer discuss with the men in the boiler room, or elsewhere, any suggestions they may make concerning better and more efficient operation. Talking over these suggestions furnishes an opportunity to find out whether the operators are familiar with the working principles of the equipment involved. If they are not well informed, the watch engineer should explain such points as are not clearly understood or arrange to have these explained by someone who is fully informed. It might be well to point out to these men that the faulty performance of a minor detail in the operation of the station may not mean much at the time, but, if allowed to continue, it may cause a considerable reduction in the efficiency of the plant.

A watch engineer should study his men and their respective jobs in order to determine whether the men are fitted to handle their work efficiently.

It is essential that he review the daily charts and log sheets and compare the results and conditions from day to day, as this will enable him to give the necessary attention to any weak points in the operation.

By closely observing all maintenance work, especially when he is on the day shift, he will be able to determine what effect certain operating conditions have had on the equipment that is under inspection or being repaired.

The general log sheet should bear the signature of the watch engineer. FRED W. HALTER.

Minneapolis, Minn.

Ammonia Condensers

A speaker before an audience of refrigerating engineers stated that the bleeder-type ammonia condenser had an advantage over the straight top-feed condenser in that it would cool the ammonia closer to the cooling-water temperature, and that the removal of the liquid at the bleeder points increased the amount of condensing surface. Continuing, he stated that the double-pipe condenser was also built on the flooded principle, taking advantage of the increased heat transfer between liquid ammonia and water over the transfer between hot ammonia gas and water.

If this latter statement be true, I would be interested in having some engineer explain what advantage lies in bleeding the liquid from the bleeder-type condenser. It is my opinion that the bleeder type is not superior to the old top-feed type.

Because a flooded type condenses more gas per square foot of surface, the impression prevails that a wetted surface is of advantage. The fact is that the progressive condensation of the gas reduces the effective pipe cross-sectional area and helps keep the gas velocity constant. If a top-supply condenser were built with pipes of a diminishing section from top to bottom, the heat transfer would equal that of the flooded condenser.

St. Louis, Mo. M. H. MILLS.

Comments from Readers

Why Did the Steam Fail to Heat?

In the Nov. 17, 1925, issue under the heading, "Why Did the Steam Fail to Heat?" A. F. Sheehan said: "Occasionally, problems have to be solved by methods that are directly opposed to engineering theory" and told of a case where live steam at 8 lb. pressure failed to heat a factory room, where exhaust steam at 1 lb. pressure did heat the room satisfactorily. He also said: "Looking at the problem from the theoretical side, the live steam at 8 lb. pressure and 235 deg. temperature should have raised the room temperature higher than did the exhaust steam at 1 lb. pressure and 215 deg. temperature."

Of course, I cannot say why the live steam failed to heat in Mr. Sheehan's case, but I never knew a case where live steam at a higher pressure failed to raise the room temperature as high as or higher than, exhaust steam, except where there was a good reason which was not opposed to engineering theory. I had a case some years ago that looked suspicious at first, but it was finally analyzed and the mystery disappeared.

The heating of this particular factory was done with exhaust steam at 1 lb. pressure. The office occupied the whole third floor of a wing which was 30 by 100 ft. This wing was heated with exhaust steam fed through a 3-in. pipe from the main building. There was a 3-in. valve in this pipe just after the pipe entered the wing, which could be closed and live steam used to heat the wing, separately from the main building. The live steam was supplied through a 1-in. pipe direct from the boilers, and after it entered the wing it was passed through a ¾-in. reducing valve past a gage, through a globe valve, several nipples and elbows and into the 3-in. line on the wing side of the 3-in. valve.

When I first went there, the factory was running only five days a week and the office was heated with live steam on Saturday morning. I had complaints about the office being cold and went up to find the trouble. Some of the radiators were fairly warm and others cold, while others were part warm and part cold, and this was after the steam had been turned on for seven or eight hours.

They told me in the office that this condition had existed for several years and that they always dreaded to come to work in cold weather when the factory was not running. I talked with the superintendent, who was much puzzled that live steam at 15 lb. pressure (the gage near the reducing pressure valve showed 15 lb.) would not heat the rooms, when exhaust steam at 1 lb. pressure heated them nicely.

It did seem to be opposed to engineering theories, and I started an investigation. As an experiment I opened the 3-in. valve to let the steam from the wing into the main building, expecting to see the pressure drop, but it remained the same. Then I closed the valve and opened a trap at the end of one of the coils and no steam came out, in fact there was a vacuum from the pump. The analysis then showed that there was so much resistance to the flow of the steam through the globe valve and elbows that the gage showed 15 lb. pressure when there was not enough steam in the pipes to fill them. I had the globe valve taken out, which improved matters somewhat, and the gage would show only 2 lb. Then I had a 1¼-in. reducing valve and fittings put in, set the valve for 5 lb., and the rooms would heat quicker with the live steam than with exhaust steam.

If Mr. Sheehan gets 8 lb. pressure in the coils, then I think that the air and water do not get away. If the steam was turned on very fast, it might trap the air in the coils or possibly the traps will not work satisfactorily on the higher pressure. In any case, when the cause is found I do not think it will be opposed to engineering theories. W. D. THROOP.

Norwich, Conn.

Surplus of Engineering Graduates an International Phenomenon

With reference to the discussion on the prospects of engineering students I should like to advance a somewhat personal point of view.

The surplus of graduates seems to be an international phenomenon and is simply a result of the law of supply and demand. Engineering appeals to many young men, and the majority of them believe that their success is assured when they have finished a three- or five-year course at a technical college or, properly speaking, after having secured an engineering diploma. The majority of these students have to exert themselves to the utmost in order to master some branches of engineering, and in many cases a broad education is not acquired, which, after all, is necessary if an engineer wishes to be placed in line with other professional men.

The industry needs considerable more subordinates than leaders, but since the world war, everybody wishes to go "higher up," consequently an alarming number of mediocrities want to be prepared in a minimum of time in order to be able to fill a relatively small number of important positions.

Even boys that attend the courses at a junior technical school where engine fitting and elementary machine drawing are taught, often do not persevere and are anxious to become draftsmen or marine engineers, both branches that are already overcrowded. Owing to the ever-increasing need of skilled machinists and repairmen a number of companies have introduced an apprentice system, and the boys that finish the four years' course receive in addition to their wages a premium of 150 guilders.

Thus the practical side of engineering is neglected at present, at least in this country and other parts of Europe. We may safely conclude that it takes time to become a skilled machinist or erector and the conditions in machine shops are far from ideal, but it is quite possible to make a living out of it, and the man that combines technical knowledge and manual skill has in general more chance to become independent than the average technical graduate. U. WIELAND LOS.

Schoonhoven, Holland.

Engineering and the Man

Referring to the letter by Robert H. Emerick in the Sept. 8, 1925 issue on "Engineering and the Man," I should like to add to what has already been said on this subject.

The poor remuneration and standing of the *average* member of the engineering fraternity at a time of greatest prosperity in which few workers, skilled or unskilled, fail to share, has engaged the minds of the engineering profession and brought about numerous discussions as to the reasons for it and the possible remedies. Manifestly, no profession can thrive and progress if the majority of its members do not earn sufficient to maintain those dependent upon them in reasonable comforts and leave a few dollars for association dues, books, periodicals, fraternal associations, etc. That the engineer, on the average, does not earn an income sufficient for normal and healthy development seems to be the consensus of opinion of those who have discussed the subject. They differ widely, however, in the reasons they offer for this peculiar condition and the remedies they suggest.

As little has apparently been accomplished by the extended discussions, there is a suspicion that the reasons offered are incorrect and the remedies suggested are consequently ineffective, for it is an old established maxim that once the real reason for an abnormal situation is found, the remedy suggests itself.

Those who have taken part in the discussion, seem to be divided into two groups. On one side, it is claimed, mostly by those affected, that the engineer by his training, efforts and services rendered is entitled to better consideration, but simply does not receive it, for reasons unknown. On the other side it is claimed that the engineer gets just what he earns, and if he doesn't get any better consideration he has nobody but himself to blame for it; he does not earn and does not deserve more. As recently pointed out by Mr. Emerick, "It isn't the engineering, it's the man."

If the engineer earns better consideration, why doesn't he get it? If it's the man and not the engineering, how could the following extract from a letter written by one of the large industrial organizations in the country to a man whose record showed six years of technical training and twelve years of good experience and achievements, be accounted for?

> The duties of the position which we have open as assistant master mechanic consist of directing and supervising about 100 mechanics in shops and throughout the plant on maintenance and minor construction work in a chemical industrial plant. There is also considerable estimating and ordering of material included. An applicant must be a good handler of men. A salary of $150 per month will be paid to start with.

This letter, except for the last line, was shown to about fifteen professional (not technical) and business men. The estimate of the salary such a position should bring was between $10,000 and $25,000 a year.

If "It isn't the engineering, it's the man," how could the following advertisements for engineering executives at less than $50 a week be explained?

> MECHANICAL ENGINEER, as mechanical superintendent, experienced in maintenance and construction, who can and will assume responsibility for keeping equipment, of an abrasive company in good operating condition and also install such new equipment as may be needed. Knack of making improvements in the equipment desirable. Would have charge of the construction and repair force. Must be good executive. Apply by letter. Salary $2,200-$2,500 a year. Location, N. Y.

> ASSISTANT OR ASSOCIATE PROFESSOR, of geology and mineralogy, 25 or older, with master's degree, although a bachelor's or engineering degree might be acceptable under certain circumstances. Must be in good health, with no physical defects and one or two years' experience in teaching geological subjects. Must have good character and morals, pleasing and forceful personality, adaptability, willingness to co-operate, and teaching ability. Subjects to be taught are general geology, mineralogy, petrology, petrography, paleonto'ogy, oil and gas geology, structural and metamorphic geology, field geology and applied geology. Salary, $2,300-$2,700 for nine months beginning September 1, to be paid in twelve equal installments beginning October, 1925. Location, Middle West.

Such ads could be quoted by the thousands. No difficulty is experienced in filling these positions. In fact, those familiar with the subject will testify that replies to such ads are received by basketfuls, from men exceeding the qualifications specified.

How would it be explained that engineers charged with the responsibility of checking and approving plans of million-dollar buildings are receiving $1,500 to $2,000 a year, as recently brought out in a court proceeding attempting to fix the responsibility for the collapse of the steelwork of a theater under construction, resulting in the death of twelve workmen.

If "It isn't the engineering, it's the man," how could the fact that so many engineers fail to measure up to their positions be explained? Future engineers are being recruited from the same ranks as future members of other professions. By what process or method do other professions secure a larger proportion of real men, than engineering? If the raw material is the same, why such a vast difference in the finished product? Or does engineering require superhuman genius for success?

It has been recently pointed out by an eminent psychologist that the world's work is being carried on by the vast army of mediocre men and that by their honest and persistent efforts they earn and are entitled to as much comfort and pleasure in life as geniuses have. It is my opinion that supermen and geniuses need no champions. They are quite capable of taking care of themselves. It is the average mortal that we are concerned with in all these discussions. And if engineering has nothing to offer to the average human being, this fact should be made known and only men endowed with superhuman abilities permitted to follow the profession.

The engineering profession requires no more superhuman ability than any other branch of human endeavor, and engineering students are recruited from the same ranks as candidates for other professions. On the average, engineers are of the same intelligence as members of other professions. Neither is there anything in the attitude of the public toward the engineer different from that toward other professions. The public gives as little as it possibly can to any profession. How little depends upon the members of the profession. They, not the public, set the standard for engineering services. It is that standard the public has to pay and does pay.

Having thus questioned the rationality of the reasons advanced and the effectiveness of the advocated remedies, it behooves one to offer some new hypothesis that will successfully replace the old ones. This I do not claim to be able to do. I do hope, however, to indicate a few lines of investigation that I believe will lead to the root of the evil instead of into a blind alley.

To begin with, we must concede that engineering students are recruited from the same ranks as those

of other professions and that their average intelligence is on a par with that of other college boys. If the raw material is not inferior, the difference in the quality of the finished product can be accounted for only by the kind of training they receive, and I submit that there is where 75 per cent of the trouble lies. Take a batch of young men in the freshmen year. Full of "pep," enthusiasm, ambition, self-confidence, determination and persistence. Look at what is left of them, both in quantity and quality, for the commencement exercises, after four years of severe training and endurance test. A mere handful of meek, docile men ready to take any job fate throws their way, looking for someone to give them a job and keep them in it. Look at them after 10 or 15 years' experience! What has become of the enthusiasm and ambition they possessed when they entered the profession. Isn't the answer plain? It was killed during the four years of training. It was buried during the first years of experience by the irony of fate and the cynicism of the associates who had had several years of experience. And as some of us reflect on our training years, we must admit that the results were inevitable and only a superman could escape them.

During the training years, for the greater part of the time we were guided by instructors who had little or no experience with actual engineering problems. They were bright men, honor graduates, and for that reason favored with appointments as instructors, gradually advancing to assistants and professors. They were intrusted with the great responsibility of preparing young men for their life work, work which they themselves had not done, and perhaps could not do if called upon. Could they be expected to kindle the spark of vision, determination and enthusiasm, qualifications more important for life's work than the knowledge of hyperbolic functions? And the heads of the departments! They seem to consider it their sacred duty to impress upon the students that after four years' training, they will know nothing, that they will have to find jobs to get the experience and that for the first three years at least, their employers will be losing the 22c. per hour they are paying. Is there any wonder that the aspirations the young men possessed are slowly but surely poisoned and the engineering graduate leaves school a jumble of positive knowledge he does not know where and how to apply, looking for someone to give him a job, to show him how to apply his knowledge? Does he regain his confidence, vision, enthusiasm, etc.? Seldom! He remains a job hunter and job holder for the rest of his life, finding it harder and harder to secure and hold one as he matures in age and experience.

In contrast to the engineer, other professional men are trained for immediate independence. Notwithstanding the fact that in their professions, such as law, accountancy, dentistry, medicine, etc., experience is just as important as in engineering, only a few accept positions and then only temporarily. While they are acquiring experience, they do not neglect building up their own clientele.

Suppose a young engineer had sufficient vision and courage left in him to attempt for independence and consulted his idol, the professor or some successful engineer? What would the answer be? "No. Not until you have had at least ten years of experience!"

Just how hollow the awe-inspiring word experience is, will perhaps be apparent from the following record. A technical graduate was thrown by fate into illuminating engineering. He remained at that work for more than four years, when he was compelled to seek new employment. Having four years' experience in illuminating engineering and having passed an examination covering electric-railway work, such as design of air brakes, size of motors required to pull a train or a given weight, on a given grade, at a given acceleration, multiple-unit control, etc., he was assigned to make a physical inventory of a public utility. Not finding the work congenial, he was again seeking employment. With four years' experience in illumination and about a year in appraisal work, he secured employment on the test floor of an electrical machinery manufacturer. A year or so later he was again compelled to seek new employment. He found it with a railroad. On the strength of his experience in illuminating engineering, in appraisal work, in testing electrical machinery, the first job he was assigned to, was the checking of the factor of safety of a structure under the load of additional equipment. The second job was the design of a ventilating system for a labyrinth-like subcellar where an ammonia refrigerating machine was located. The third job was the design of hangers and anchors for a 10-in. temporary steam main. Next he tried his luck with an industrial organization. Because of his previous and somewhat varied experience, he was assigned to test boilers, turbines, etc. He carried out the assigned work to the complete satisfaction of his superiors, was never fired and his salary increases came unsolicited. Other engineers undoubtedly have similar records, which, in my opinion, proves that the fact that one never was shown how to do a certain thing should not hinder him in doing it. In fact, to my mind, the engineer who must have experience in order to tackle problems properly, is indeed a sorry figure.

Between 1919 and 1923 I had to train three chemical engineers in power-plant work. Each had practically the same story to tell. They were enticed by the numerous articles and speeches from apparently responsible sources, of the opportunities in the chemical engineering field, that appeared during the war. The romance of chemical engineering held their fascination and lured them to invest four years in the study of it. They have made an honest effort to secure application for their training but without success and have therefore been obliged to seek employment in other lines.

I honestly believe that if engineers would stop bluffing and the truth became known, 80 per cent of engineering schools would have to close their doors for lack of enrollment. For only a small percentage are fortunate enough to be able to follow a certain profession for the love of it.

The closing of 80 per cent of our technical schools would in my opinion be a veritable act of benevolence. Twenty per cent of the present output of technical schools is all the industry can absorb, all it does absorb. The rest have to turn to other vocations after wasting 8 to 10 of the best years of their lives. One would suppose that the industry having such an abundant supply would pick their men and that the natural law of the survival of the fittest would come into play. This is far from being the case.

To sum up: To accomplish anything, we must get at the root of the evil. The latter, I believe, will be found to be distributed about as follows: Mistraining, 75 per cent; "free" engineering services, 15 per cent; bluff and myths regarding engineers' incomes, 10 per cent.

New York City. E. OGUR.

Questions and Answers

Conducted by

Franklin Van Winkle

Grooves in Engine Bearings

Should engine bearings have oil grooves cut in the babbitt or brass? *W. O. G.*

The bearing should have shallow oil grooves cut into the babbitt and leading from the oil inlet. The grooves serve to distribute the oil. If cut too deep, they seem to break up the oil film. Likewise if cut too close to the bearing ends, oil can escape more easily, so they should never extend to the ends. The oil inlet should be located at the point of minimum oil pressure and never at or near the bottom, unless pressure feed is used. Grooves should never be cut in the lower bearing.

Steam-Pipe Coils for Heating Fuel Oil

What allowance of pipe surface should be made for heating fuel oil by means of steam pipe coils made of copper or of steel pipe? *J. D.*

With ordinary circulation of the oil, copper pipe coils supplied with live steam will transmit to fuel oil 38 to 42 B.t.u. per square foot of external surface per hour per degree difference between the temperature of the steam inside and the temperature of the oil outside of the coil. For steel pipe the rate is 24 to 28 B.t.u. per hour per square foot per degree difference. The rate of heat transfer increases with increase in the velocity of flow of the oil that is in contact with the heating surface. The sulphur content in fuel oil will soon deteriorate copper heating coils, and it is customary in practice to use steel pipe, although it may require more pipe to accomplish the same result.

Charging Refrigerating System with Ammonia

What is the best procedure to follow in putting the initial charge of ammonia into a refrigerating system? *G. R. S.*

To charge the machine, a drum of anhydrous ammonia is connected by a suitable pipe to the charging valve on the liquid receiver. Allow ammonia to enter the system through the charging valve until a pressure of about 15 lb. per sq.in. is recorded on the gage; next turn on the condensing water and start up the machine slowly. The suction and discharge stop valves at the compressor should be wide open while the system is being charged. When one tank is emptied, the charging valve should be closed and another tank placed in position, this being repeated until the system is sufficiently charged for work, at which time the charging valve should be closed and the main expansion valve adjusted. The ammonia drums should be weighed before and after being emptied or partly emptied, and a record kept of the amount necessary for charging. The glass gage on the liquid receiver will show the amount of liquid contained, and the pressure gages, as well as the gradual cooling of the brine in the refrigerator and the frost collecting on the expansion pipe, will indicate when a sufficient amount of the refrigerant has been inserted to start operation of the plant.

Effect of Altering Valve Setting

The indicator diagrams shown in Fig. 1 were taken from a 12x36-in. Corliss running at 94 r.p.m. After adjusting the valves the diagrams reproduced in Fig. 2 were taken. What criticism can be made? *B. G.*

As shown in Fig. 1 admission at the crank end was too late, while release on the crank-end diagram was also late, causing a higher back pressure during part of the return stroke. Since this does not occur on the

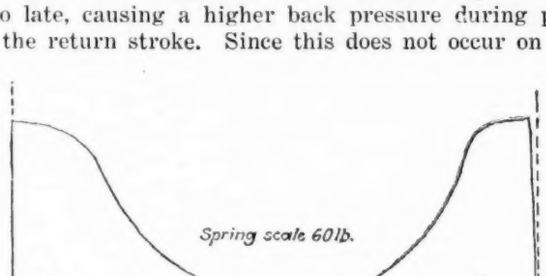


FIG. 1

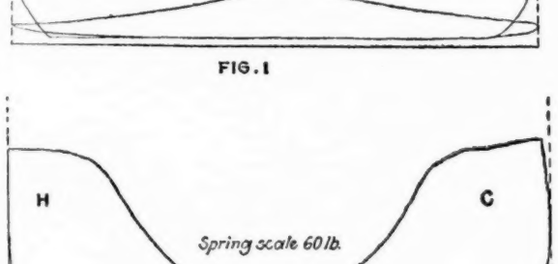


FIG. 2

Figs. 1 and 2—Effect of improper valve setting

head-end diagram, the crank end exhaust valve link is not of the correct length to give the proper lap. Evidently, the eccentric was shifted ahead inasmuch as release R and compression C is early on both diagrams in Fig. 2. However, crank-end admission is still late. It is recommended that the eccentric be shifted back to a point where it was originally. The exhaust links should then be adjusted to give correct release on both ends. The crank-end steam valve link should be altered to decrease the lap and so make the valve open earlier.

News in the Field of Power

Sugarloaf Dam, Victoria, To Be Utilized for Power

When the Sugarloaf Dam in the valley of the Gouldburn, Victoria, is completed, storage for 900,000 acre-ft. of irrigating water will be provided, according to the *Engineer*. It has now been decided to utilize the water for power purposes as well, the item states.

Switzerland Exposition To Be Held in June

An International Exhibition for Inland Navigation and the Utilization of Hydraulic Power will be held in Basle, Switzerland, from July 1 to Sept. 15, 1926. This exposition is to celebrate the opening of the new Rhine port. Foreign firms, companies, associations, etc., have been invited to participate in the celebration. Dr. Rudolph Miescher is the president of the Organizing Committee, and Dr. W. Krasting is secretary, Basle, Switzerland. A notice of this exhibition was printed in *Power* last year.

Success of Chicago Power Show Assured

At this writing practically the entire available space in the American Exposition Palace of the Furniture Mart Building has been allotted and an exhibit approximating 300 booths is assured. The exhibit will be arranged in group display according to the product, and the latest and best in power-plant equipment will be shown effectively on one large floor.

Sponsored by Midwestern Engineering Exposition, Inc., the show will be one of the best ever held in this section of the country. It will bring out what is new in the way of powdered-coal equipment of all types, air preheaters, water-cooled furnace walls, stokers, draft apparatus and other devices to increase the effectiveness and economy of combustion. There will be a particularly attractive exhibit of electrical equipment with switchboard display, instruments, oil switches, etc. Valves of all types for the higher pressures and temperatures, regulators and many other power-plant specialties will be on exhibit. New features in boiler design and in auxiliaries for all departments of the power plant will be shown, and there will be a complete display of heating and ventilating specialties — in fact, the show in its entirety will give an excellent idea of the present status of the art and the progress that has been made in all lines of equipment used in the power plant.

Beginning on Tuesday, Jan. 26, and continuing through Saturday, Jan. 30, the show will open promptly at 12 o'clock noon and close at 10:30 p.m.

Federal Arbitration Law Effective Jan. 1, 1926

The Federal Arbitration Act, which was signed by the President on Feb. 12 of 1925, as reported in *Power*, March 10, page 897, became effective on Jan. 1. It is thought that it is an important step toward the elimination of waste in business, and the promotion of prompt justice.

By this law, written provisions for arbitration in maritime transactions or in contracts evidencing transactions involving commerce with foreign nations or among the several states, for the first time, are made enforceable in the federal courts. If so contracted, judgment may be entered on the awards of arbitrators by simple procedure.

Awards may be vacated by the courts only if procured by improper means, if the arbitrators were guilty of misconduct or if they exceeded or improperly executed their powers in material manner.

Arbitration Has Been in Operation Silently for Some Time

Officials of the Commerce Department, in discussing the new law, explained that arbitration has been in use in unspectacular ways by American business for many years. According to those officials the framers of the law and those who have been in touch with functioning arbitration tribunals are confident that with the enlarged field opened by the federal law and the increasing number of states adopting similar laws, arbitration in the future will avoid much of the mental wear, irritation, and disruption of business incident to litigation and that the resulting economies will be large.

They say the law is supported by business men as a time and money saver and by the legal element because it will relieve the courts of the burden of many disputes that frequently clog legal channels to an extent amounting to virtual denial of justice.

Trade Associations Should Appoint Boards

They suggest that trade associations, chambers of commerce and other commercial bodies, who desire to promote the use of arbitration, should set up arbitration bureaus, boards or groups to deal with disputes not only between their members, but between their members and outside business organizations and, where feasible, between business organizations not connected with them.

To aid business men interested in arbitration, the Department of Commerce, through its division of commercial laws, will endeavor to furnish information within the scope of its activities concerning operation under the federal law and the arbitration of international disputes.

Oregon Accepts the A.S.M.E. Pressure Vessels Regulations

The Chief Inspector of the Bureau of Labor of the State of Oregon has announced that the State of Oregon has adopted Section 8 of the A.S.M.E. Boiler Construction Code, which will become effective Feb. 1, 1926.

This section consists of the rules for the construction of unfired pressure vessels and means that all such vessels constructed and installed in this state after Feb. 1 must comply with this provision.

N. Y. State Niagara Gorge Activities Questioned

Question has been raised as to the real purpose of the State of New York in its recent activities in regard to the gorge development at Niagara Falls. Opinion is expressed in some quarters that the state is not so concerned in obviating possible conflict between a license issued by the state and one issued by the Federal Power Commission as it is in the maneuvering of matters into a situation whereby the state would have a favorable opportunity to reopen its suit against the Federal Power Commission.

Engineering Foundation Has Announced Its Platform

The Engineering Foundation, organized for the effective conduct of research under the auspices of the four major national engineering societies and initially endowed by Ambrose Swasey, has just adopted, after due deliberation, the following declaration of its present plan and policy:

1. Engineering Foundation regards engineering research as the preferred field for its activities.
2. It will select or approve specific researches which it will assist by appropriation of funds or otherwise.
3. It will select for each project the agency, collective or individual, which it deems most effective.
4. It will assume no direct responsibility for the prosecution of any specific research.
5. It will co-operate with the national engineering societies and preferably support researches approved by it sponsored by one or more of them.
6. A member of Engineering Foundation or of its staff may be an advisory, but not an active, member of any committee or other organization in immediate charge of a research assisted financially by the Foundation. This provision will not be retroactive.
7. Engineering Foundation reserves the right to require from committees or other organizations or individuals assisted satisfactory progress reports as a condition of continued support.
8. Engineering Foundation will co-operate with the several founder or other national engineering societies in raising funds for the prosecution of approved researches.
9. It will endeavor to prevent conflict or overlap of research effort among the agencies which it supports or assists.
10. It will co-operate in securing information of the state of the art for use of committees of the founder societies or other agencies.

Ritchie Says Maryland Could Not Finance Conowingo

Governor Ritchie, of Maryland, has refused to call a special session of the Legislature at the request of labor unions to repeal the charter rights under which the Susquehanna Power Co. and its allies propose to develop the Conowingo water power project and to provide for state ownership of the project.

In a letter to several unions the Governor said there was serious doubt about the constitutionality of state development and ownership of such an enterprise and that he did not feel that the purpose suggested for the special session would be for the public interest.

"Engineering investigations," the letter continued, "show that the cost of developing the water power for Maryland purposes would not be less than $30,000,000 to $40,000,000.

"Even if competition in electric current in Baltimore would be desirable, which, in my opinion, it would not be, it would still be inconceivable for the state to raise and spend so vast a sum for the purpose."

Merchants Erect Tablet to Henry R. Towne

A tablet in memory of its former president, Henry R. Towne, has been erected by The Merchants' Association upon a pillar flanking the main entrance of the Association's office in the ninth floor of the Woolworth Building, New York City.

Mr. Towne, head of Yale & Towne lock manufacturing company, was a past president of the A.S.M.E., 1889, and prominently identified with the society until his death. After his death in 1924, when his will was read, it was disclosed how great had been his interest in matters connected with engineering through his gifts. He left $50,000 for a Henry R. Towne Engineering Fund to be administered by the United Engineering Societies; $10,000 in trust to the Franklin Institute in memory of his father, John Henry Towne. He also felt the need of an industrial museum leaving $50,000 for a campaign to bring prominently to public notice the essential facts concerning the great industrial museums of Europe. The bulk of the residuary estate will, after the death of his son, be used to establish a Museum of Peaceful Arts, for the people of New York City.

The tablet contains the following inscription:

To the Memory of
Henry Robinson Towne
August 29, 1844 October 15, 1924
Lofty of Mind—Warm of Heart—Pure of Soul. Clear in Vision—Sound in Judgment—Generous in Act and Deed. A Creative Genius—Builder of Business—Leader of Men—Devoted Citizen.
President and Guide of The Merchants' Association of New York Into Wider Fields of Worthy Service.
An Example of Inspiring Citizenship.

TO THE MEMORY OF
HENRY ROBINSON TOWNE
AUGUST 29 1844 – OCTOBER 15 1924
LOFTY OF MIND WARM OF HEART PURE OF SOUL CLEAR IN VISION SOUND IN JUDGMENT GENEROUS IN ACT AND DEED A CREATIVE AMERICAN BUILDER OF BUSINESS LEADER OF MEN DEVOTED CITIZEN PRESIDENT AND GUIDE OF THE MERCHANTS ASSOCIATION OF NEW YORK INTO WIDER FIELDS OF WORTHY SERVICE
An Example of Inspiring Citizenship

Memorial Tablet to Henry Robinson Towne

New Tri-State Power Compact Suggested

Dr. Charles Browne, of Princeton, a member of the New Jersey Public Utility Commission and chairman of the Tri-State Power Conference appointed by Governor Pinchot, Governor Silzer and Governor Smith, has drafted a proposed interstate compact designed to overcome the objections which caused the New York members to withdraw from the conference at a meeting in that city on Dec. 22, as reported in *Power*, Dec. 29, page 1031.

The object of the three governors was to bring about an agreement by Pennsylvania, New Jersey and New York for the supervision and regulation of transmission and distribution of electric power between the states becoming parties to the compact.

The New York members concluded that such a compact would be impossible without abrogating the powers of that state to regulate its own corporations and on that ground withdrew. Since then the New York members have signified a willingness to reopen negotiations provided the objections which they regarded insurmountable could be overcome.

Dr. Browne's compromise suggestions have been approved in general by Governor Silzer and Attorney General Katzenbach, of New Jersey, as well as by the New Jersey members of the commission and will be submitted to the Pennsylvania and New York members for consideration.

The interstate compact as now proposed provides for an interstate power commission composed of the Public Utility Commissions of the compacting states. It provides that nothing shall limit or restrict the regulatory powers conferred by the several states upon their Public Utility Commissions, but rather that the powers shall be supplemental to those already possessed and applicable to the region in which electric companies engaged in interstate traffic may operate.

In general the proposed compact would extend the jurisdiction of the Public Utility Commissions, acting as an interstate body, to the regulation and supervision of so much of the operations of electric companies as may involve interstate transmission or distribution of power. That would include provisions for adequate service, fixing of reasonable rates, uniform system of accounting and such other regulatory measures as might be necessary.

In the event of inability of two or more of the compacting states to agree, the Interstate Commerce Commission might be requested to act as arbitrator.

Electrotechnical Commission To Meet Here in April

Arrangements have been perfected for the holding of a meeting of the International Electrotechnical Commission, an organization constituted by representatives of twenty-two countries and whose activities were outlined in *Power*, Oct. 20, page 627, in New York City at the Astor Hotel beginning on April 13.

The United States National Committee, I. E. C., of which C. H. Sharp is president and F. V. Magalhees is secretary, is arranging the preliminaries for the meeting. It is expected that the foreign delegation will arrive a day or so before the meeting and arrangements are being made for an American tour for these delegates after the meeting. J. W. Lieb is chairman of the reception committee and H. H. Barnes is chairman of the subcommittee on entertainment.

Stimulated by the interest shown at the World Power Conference in the development of international test codes for prime-movers the Commission is laying plans to employ its machinery to bring about as much unity as possible among the recognized prime-mover test codes of the several countries.

Pennsylvania Legislature To Consider Power Subjects

The special session of the Pennsylvania Legislature which has been called by Governor Pinchot to assemble on Jan. 13, will consider among the eight stated subjects: Regulation of the anthracite coal business, laws providing for the carrying out of the Governor's giant power plans and approval of the Delaware River tri-state compact with New York and New Jersey.

The Governor is explicit about his giant power plans, which were rejected by the 1925 Legislature. He then had nineteen bills before the House. This time fewer bills, but measures covering the essential points of the others, are proposed. These would define the power of a giant power board, authorize incorporation of giant power companies, provide for cheaper distribution of electrical energy, regulation of rates and service and authorize incorporation of generating companies. The purpose of the entire series of bills is to prevent "the great electrical monopoly now being consolidated" from being formed without proper consideration for the public welfare.

"The supreme importance of giant power," the Governor said, "is one of my reasons for calling this extra session." Main emphasis, however, is put on his plan to declare the anthracite-coal industry a public utility and to provide for its regulation by the state.

Colorado River License Suspension Alarms Some

Friends of the Waterpower Act are alarmed by the unanimous action of the Senate in suspending with Feb. 1, 1928, the "jurisdiction, power and authority of the Federal Power Commission to issue licenses for the purpose of constructing, operating and maintaining dams or reservoirs on the Colorado River and its tributaries" (see *Power*, Dec. 29, page 1029). It is expected that similar legislation will be introduced suspending the operation of the Waterpower Act on the Tennessee and on the Columbia.

The effect of such legislation, some contend, is to suspend the public safeguards of the Act and pave the way for the surrender of national rights or for gifts of public property.

In the case of the Colorado River the Public Lands committee on one day reported favorably on a joint resolution, introduced by Senator Pittman of Nevada, and the next day passed the resolution by unanimous consent. Not an inquiry as to the effect of the action was made by any member, when this far-reaching legislation came before the Senate.

Senator Pittman urged the passage of the measure, so that no state could obtain an advantage on the Colorado River pending the ratification of the Colorado River Compact. He expressed the opinion that Arizona is encouraged to stay out of the compact which the six other states have ratified "by reason of the hope of obtaining through the Federal Power Commission the rights to build dams within the State of Arizona without regard to the effect it may have upon the rights of other states."

Since the Senate acted before any opportunity was afforded to hear from the Commission, it is expected that the real consideration of this matter will take place in the House.

It is not improbable that an effort will be made in the House to amend the resolution, so as to make it cover the Boulder Canyon Dam as well. If this is done, the measure will lose the support of the public-ownership group.

The Pittman resolution was transmitted promptly to the House of Representatives where it is being held on the Speaker's table pending a decision as to the committee which has jurisdiction. Some favor the reference of the measure to the Public Lands Committee, while others think it should go to the Committee on Irrigation and Reclamation.

Bureau of Mines Reports on Coal Stocks

On Nov. 1, 1925, the stocks of bituminous coal in the hands of consumers were approximately 48,000,000 net tons, according to the Bureau of Mines. This was slightly larger than in the corresponding period of 1924. On June 1, 1925, stocks amounted to 38,000,000 tons. Between June 1 and Sept. 1 consumers added 5,000,000 tons of their total reserves, and between Sept. 1 and Nov. 1, another 5,000,000 tons. From the trend of production and consumption it is apparent that the flow of coal into storage has continued since Nov. 1.

In comparing the stocks on different dates, it is necessary to consider the current rate of consumption, which varies. At the rate prevailing in September and October, when business was active and consumption large, the stocks on Nov. 1 were sufficient to last 35 days. This may be compared with a supply of 45 days on Sept. 1, 1924, when business was dull; and with a supply of 46 days on Sept. 1, 1923, and 23 days on Nov. 1, 1922. But these averages, however useful for comparison, overlook the fact that stocks are never equally divided. Some consumers and localities are exceptionally well supplied, and others have practically no reserves.

In addition to the storage piles of consumers on Nov. 1, there were 7,512,000 tons of bituminous coal on the docks of Lakes Superior and Michigan, at least 221,000 tons held in storage by producers at the mines or intermediate points, and 503,850 tons in railroad cars unbilled at the mines.

Anthracite

On Sept. 1, when the anthracite strike began, retail dealers had on hand a supply sufficient to last 53 days, at the rate they were delivering to their customers in September and October. By Nov. 1 retail stocks of anthracite had been reduced to 27 days.. In the meantime retailers had increased their stocks of bituminous coal.

A group of 21 byproduct coke plants selling domestic coke, available as substitute for anthracite, reported 599,000 tons of coke in stock on Nov. 1.

Wage Earners and Horsepower

(From Census of Manufactures)

	Total Figures — All Types of Power			Detail Figures — Prime Movers				
							Secondary Power (Driven by Purchased Power)	
Year	Horsepower per Wage Earner	Total Wage Earners	Total Horsepower	Steam Engines and Turbines, Total Horsepower	Internal Combustion Engines, Total Horsepower	Waterwheels and Turbines, Total Horsepower	Electric Motors, Total Horsepower	Other Power
1923	3.77	8,778,950	33,094,228	16,695,493	1,230,302	1,802,805	13,365,628	(1)
1919	3.24	9,096,372	29,504,792	17,037,973	1,259,400	1,765,263	9,347,556	94,600
1914	3.19	7,036,247	22,437,072	15,591,593	991,905	1,826,443	3,897,248	129,883
1909	2.82	6,615,046	18,675,376	14,228,632	751,186	1,822,888	1,749,031	123,639
1904	2.47	5,468,383	13,487,707	10,917,502	289,423	1,647,880	441,589	191,313
1899	2.14	4,712,763	10,097,893	8,189,564	134,742	1,454,112	182,562	136,913
1889	1.40	4,251,535	5,938,635	4,586,089	8,930	1,255,045	(1)	88,571
1879	1.25	2,732,595	3,410,837	2,185,458	(1)	1,225,379	(1)	(1)
1869	1.14	2,053,996	2,346,142	1,215,711	(1)	1,130,431	(1)	(1)

Salvador To Have New Power Supply

Engineers from the United States are in Salvador, Central America, studying plans to develop the waters of Lakes Guija and Ilopango to provide power for an electric lighting system to supply all the towns of Salvador.

To Consider Tennessee River Applications in February

The Tennessee River development applications, which were considered at the recent public hearing in Chattanooga, will not be ready for presentation to the Federal Power Commission at its Jan. 15 meeting, it is reported. These applications, it is stated, will probably be ready to present to the Commission for action by the middle of February.

Johnson Introduces Another Boulder Dam Bill

A bill was introduced in the Senate of the United States by Mr. Johnson on Dec. 21, S 1868, to provide for the protection and development of the Lower Colorado River Basin. It provides that the Secretary of the Interior be authorized to construct a dam and incidental works on the Colorado River at Black Canyon or Boulder Canyon and to make leases of the power privileges, limited to fifty years, on such terms and under such general regulations as he may prescribe.

The United States is to manage and operate the dam, canal, etc. which includes the delivery of water for the generation of power, irrigation, or other uses. The project is to be subject to the Colorado River Compact signed at Sante Fe, New Mex., Nov. 24, 1922. This Compact was signed by the Commissioners of the seven states interested, namely, Arizona, Nevada, California, Colorado, New Mexico, Utah and Wyoming. It failed of ratification by the Legislature of Arizona, however. The Johnson bill would change the provision of the Act of Congress of Aug. 19, 1921, under which the Compact was authorized, making the Compact binding and obligatory when it shall have been approved by the legislatures of six of the signatory states instead of seven.

The new Act is a supplement to the reclamation law, and the reclamation law is to govern the construction, financing and management of this federal enterprise in the Colorado, excepting the provisions contained in the bill.

Under the new bill, half of the capital obligation must be repaid within five years, while 4 per cent interest is to be paid on the remainder, which is to be repaid, together with all operation and maintenance charges, within fifty years.

The provision for 20,000,000 acre-feet of storage would mean a lower dam than that recommended in the report made to the Reclamation Service. The dam proposed in that report was to be 605 ft. high and provide 34,000,000 acre-feet of storage.

The bill provides an authorization for $70,000,000, the same amount carried in the former, or Swing-Johnson measure.

Brooklyn Polytechnic To Have Inauguration Jan. 13

The Brooklyn Polytechnic Institute expects a large attendance of presidents of colleges and universities as well as representatives of the engineering and learned societies at its inauguration exercises of Dr. Parke Rexford Kolbe, which are to be held in the Opera House of the Brooklyn Academy of Music. Dr. Charles Alexander Richmond, president of Union College, will give the principal address of the evening.

The Polytechnic Institute of Brooklyn is one of the oldest colleges of engineering in the country, having been established in 1854. It grants the degrees of civil, electrical, mechanical and chemical engineer, as well as B. S. and M. S. in chemistry. The college also maintains an evening department giving courses of collegiate rank leading to the same degrees.

President Kolbe comes to the Polytechnic Institute from the Municipal University of Akron, where he served as president for a period of twelve years.

International Fair in Brussels in April

The Seventh Official Commercial Fair, organized by the City of Brussels, is to be held from April 7 to 21. The fair of 1920, the first to be held, had only 1,602 participants, 429 of whom were foreigners; the 1925 fair had 2,853 exhibitors, of whom 920 were foreigners. The fair is designed to give manufacturers the opportunity of displaying their specialties to European consumers under favorable conditions. Full particulars may be had at 19 Grand Place, Brussels, Belgium or at the Belgium Consulate, 25 Madison Ave., New York City.

Disagreement on Allocation of Colorado River Waters

California's efforts to bring about an agreement as to the disposition among the lower states of the Colorado River Basin of the 7,500,000 acre-feet of water that passes Lee's Ferry have revealed wide differences of opinion as to the allocation.

California, which contributes no water to the River and which has only a few square miles in the drainage basin, wants recognition of 2,146,000 acres of perfected rights and to a diversion of 1,095,000 acre-feet for use by Los Angeles.

California would allocate 300,000 acre-feet to Nevada and 500,000 to Mexico. When all these amounts are added together a total of 4,273,000 acre-feet is obtained. This would leave 3,227,000 acre-feet of the total passing Lee's Ferry. This amount California would divide equally between herself and Arizona. This, added to the amount mentioned, would give Arizona 1,845,500 acre-feet and California 4,854,500.

The Arizona committee figures differently. Under its plan California would receive but 3,350,000 acre-feet. Arizona agrees to the 300,000 acre-feet for Nevada and the 500,000 for Mexico which, when deducted from the 7,500,000, leaves 6,700,000 acre-feet. This the committee proposes to divide equally between the two states, or 3,350,000 acre-feet each. In addition, Arizona reserves for herself the waters of her own rivers, which add 2,563,000 acre-feet to the Colorado River total. A considerable part of this latter total cannot be utilized, owing to the wide variation in the discharge of the Arizona rivers.

Engineering Societies Open Employment Branch

The Founders societies composed of the A.S.M.E., A.I.E.E., A.S.C.E. and A.I.M.M.E. are establishing a branch of the joint employment office in San Francisco at 57 Post St. The Chicago office, which was opened recently, is at 1736 Monadnock Block. This service is available to all members of these four societies.

Obituary

Herr Prof. Dr. Ing. Georg Klingenberg, the prominent German designer of large power stations and one of Germany's leading engineers, died on Dec. 7 after a severe illness. Dr. Klingenberg designed and built many of Germany's important power plants, notably the superpower station at Golpa, which in 1915 was the largest in the world. His work in connection with the designing of the Victoria Falls, South Africa, power plant brought him an international reputation. When the big station, Rummelsburg, which is in the suburbs of Berlin, was being constructed, he was called upon to help design it. He was president of the Verein Deutscher Ingenieure, Deutscher Verband Technisch-wissenschaftlicher Verein and Director of the Allgemeine Electricitats Gesellschaft. His many books and papers on the design and construction of power plants have been of distinct service to the power-plant field and have been translated into many different languages.

Business Notes

The Philadelphia Section of the A.S.M.E. will hold a joint meeting on Jan. 19 with the Engineer's Club. The subject will be "Oil and Gas Power."

The Schenectady Branch, A.S.M.E., will hold its Jan. 15 meeting at the Edison Club Hall at 8 p.m. William E. Wickenden will speak on "Better Engineers—Do We Need Them and Can We Get Them?"

The Indianapolis Section of the A.S.M.E. will hold a joint meeting with the Indianapolis Architects' Society on Jan. 19 at the Athenæum. "The Development and Engineering of Elevators" will be the subject.

The Metropolitan Section of the A.I.E.E. will hold a meeting on Jan. 29 at which the "Trend of Electric Light and Power Industry" will be discussed. The members of the Metropolitan Sections of the A.S.C.E., A.I.E.E. and A.I.M.M.E. are invited to attend.

Business Notes

The Marion Machine, Foundry & Supply Co., Marion, Ind., has recently acquired the services of Frank J. Donnelly, who was formerly with the Babcock & Wilcox Co., and is in the New York office at 30 Church St.

W. H. Nicholson & Co., Wilkes-Barre, Pa., have recently appointed the following firms to handle their steam specialties: The A. K. Miller Engineering Co., Mobile, Ala., and New Orleans, La., will handle the firm's business in Louisiana, Mississippi, southern Alabama and Florida; Smith-Meadow Supply Co., Birmingham, Ala., will take care of the northern half of Alabama; J. R. Whitman, Atlanta, Ga., will cover the entire State of Georgia; the M. K. Moore Co., Charleston, S. C., will care for North and South Carolina.

Hansen, Jones & Morey, 810 West 6th St., Los Angeles, Calif., has announced that a "No-Flow" alarm attachment for the H-J-M flow indicators and described in Bulletin 201 is being manufactured by them. The device will cause an alarm bell to be sounded in case the flow of liquid ceases in a transformer cooling system or other apparatus. A small heater coil may be attached to the bottom of the indicator body so that the instrument may be used in zero or below zero weather.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., will conduct its prime mover sales activities through a new sales organization to be located at the South Philadelphia Works. The personnel is: Howell Van Blarcom, formerly assistant to the manager of the power department of the South Philadelphia Works, becomes manager of the new prime movers sales' force; R. E. Carothers, formerly manager of the steam division of the power department of the East Pittsburgh plant, will be assistant manager; A. H. Ganshird, formerly of the large turbine East Pittsburgh plant, is to manage the large turbine section; C. G. Ong, formerly of the central-station division, Boston office, will manage the small-turbine section; P. L. Fetzer, formerly of the condenser section, East Pittsburgh, will take care of the new condenser section.

Trade Catalogs

Compressors — General Electric Co., Schenectady, N. Y. Centrifugal air compressors, single-stage, are described in Bulletin Gea-233. Operating characteristics curves and a table of rating are included.

Pumps — The Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Leaflet No. 2082, recently issued, contains descriptions, photos and charts covering the centrifugal boiler-feed pumps manufactured by the company.

Air Washers—American Blower Co., Detroit, Mich. The "Sirocco" air washer is described in Bulletin No. 1923, with many illustrations of the details of the system. A psychrometric chart and many tables are included.

Coming Conventions

American Boiler Manufacturers Association—Meeting at City Club, Cleveland, Ohio, Feb. 12.

American Engineering Council, L. D. Wallace, 26 Jackson Place, Washington, D. C. Annual meeting at Washington, Jan. 14-15.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Oil Burners Association. Leod D. Becker, 350 Madison Ave., New York City. Annual convention and exposition at Book Cadillac Hotel, Detroit, Mich., April 6-8.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 20-22.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

Association of Municipal Electric Utilities. S. R. A. Clements, 190 University Ave., Toronto, Canada. Convention at Toronto, Ont., Jan. 27-28.

Engineering Institute of Canada. Richard John Durley, 176 Mansfield St., Montreal, Que. Annual meeting at Toronto, Ont., Jan. 27-29.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, American Exposition Palace, Jan. 26-30.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Western Association of Electrical Inspectors. W. S. Boyd, 175 West Jackson Blvd., Chicago, Ill. Meeting at Hotel Sherman, Chicago, Ill., Jan. 26-28.

Valves—Schutte & Koerting Co., 1159 Thompson St., Philadelphia, Pa. The subject of Bulletin No. 8-A is the bronze and forged steel valves for medium- and high-pressure service in steam, air, water and oil lines, manufactured by this company.

Gears—The Cleveland Worm & Gear Co., 3258 East 80th St., Cleveland, Ohio. Bulletin No. 105 pictures and describes the worms and gears manufactured by this company. Drawings, tables of dimensions and pictures of installations are included.

Turbine, Mechanical Drive—General Electric Co., Schenectady, N. Y. Type D-54 mechanical drive turbine, intended for the driving of centrifugal pumps, etc., is described in Bulletin GEA-197. A sectional view of the turbine is shown.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; **mine run** except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Dec. 28 1928
Pool 1	New York	$2.75@$3.15
Smokeless	Boston	2.21
Clearfield	Boston	1.75@ 2.10
Somerset	Boston	1.90@ 2.25
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.75@ 2.00
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.35@ 2.65
Central, Ill.	Chicago	2.25@ 2.35
Ind. 4th Vein	Chicago	2.25@ 2.35
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	2.00@ 2.25
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$2.75
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	....

FUEL OIL

New York—Dec. 30, light oil, tank-car lots; 28@34 deg. Baumé, 5@5½c. per gal.; 36@40 deg., 5¼@6c. per gal., f.o.b., Bayonne, N. J.

St. Louis—Dec. 22, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.5¾c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Dec. 22, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Dec. 19, f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia—Dec. 23, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.65@ $1.71 per bbl.

Boston—Dec. 21, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.55c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — Dec. 22, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6¾c. per gal.; 26@30 deg., 7c. per gal.; 30@32 deg., 7¼c. per gal.

Chicago—Dec. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40.

New Plant Construction

California—Vel Rose Ice & Ice Cream Co., Lodi, plans the construction of ice cream and ice manufacturing plants in various sections of Northern California.

Calif., Garden Grove—City plans an election to vote $25,000 bonds for the construction of a new pumping plant, mains, etc.

Calif., Los Angeles—County is having plans prepared for the construction of first unit to hospital. Estimated cost $5,000,000. Total estimated cost $8,000,000. Allied Architects' Association, Citizens National Bank Bldg., is architect.

Calif., Los Angeles—A. W. Mankins, had plans prepared for the construction of a 9 story apartment including steam heating and refrigeration systems, swimming pool, 3 electric elevators, etc. Estimated cost $900,000. Lee Callahan & Sons, 718 Edwards & Wildey Bldg., are architects.

Calif., Los Angeles—Sun Realty & Finance Co., 742 South Hill St., is having plans prepared for the construction of a 12 story office building including steam heating system and elevators at 618-620 West 6th St. Estimated cost $500,000. Meyer & Holler, Wright & Callender Bldg., are architects.

Calif., Merced—Stewart Fruit Co., Wells Fargo Bldg., San Francisco, plans the construction of a fig pre-cooling plant at Southern Pacific Reservation. Estimated cost $40,000.

Calif., Santa Monica—Bay Cities Building & Loan Assn., 224 Santa Monica Blvd., is having preliminary plans prepared for the construction of an 11 story office and stores building at 3rd St. and Santa Monica Blvd. R. B. Peterson, 920 Santa Monica Blvd., is architect.

Conn., Hartford—Allyn Realty Co., R. J. Allyn, Pres., Asylum St., plans the construction of a 12 story hotel at Trumbull and Asylum Sts. Estimated cost $2,000,000.

Ill., Chicago—A. S. Alschuler, 28 East Jackson Blvd., Archt., will receive bids about Feb. 1, for the construction of a 6 story factory including 2 steam boilers, 30 to 50 ton ice machine, air conditioners, elevators, etc., at Superior and Sedgwick Sts., for Peanut Specialty Co., 212 West Superior St. Estimated cost $200,000.

Ill., Chicago—Cass Street Building Corp., c/o Aldefest & Williams, 605 North Michigan Ave., Archts., awarded contract for masonry, etc., for a 15 story hotel at 644 Cass St. Estimated cost $800,000. Architects will award balance of contracts soon.

Ill., Chicago—Sheridan-Aldine Building Corp., c/o Krenn & Dato, 936 North Michigan Ave., is having plans prepared for the construction of a 16 story apartment including refrigeration system at 3300 Sheridan Road. Estimated cost $2,050,000. Rissman & Hirschfield, 64 West Randolph St., are architects.

Ill., Chicago—J. S. Smith, c/o D. G. Wallace, 22 West Monroe St., Archt., is having plans prepared for the construction of a 4 story hotel at Drexel Blvd. and 42nd Place. Estimated cost $750,000.

Ill., Peoria—E. C. May & Associates, Peoria Life Bldg., awarded contract for the construction of a 13 story "Pere Marquette" hotel at Main and Madison Sts., to V. Jobst & Sons, Lenman Bldg. Estimated cost $1,500,000.

Ill., Springfield—City rejected bids for light and power plant, Sect. 2, air conditioning equipment including air filters or coolers to provide for the following electric turbines, 7,500, 4,000, 3,000 and 1,500 kw. generators. Balance of contracts awarded. Burns & McDonnell Engineering Co., 101 Interstate Bldg., Kansas City, Mo., is engineer.

La., New Orleans—E. M. Loeb, Magazine St., A. F. Commagere, 910 Gravier St., New Orleans and S. S. Joy, 2001 West Pershing St., Chicago, Ill., will soon award contract for the superstructure of an 18 story "Pere Marquette" office building including 6 high speed electric elevators at Baronne and Common Sts., here. Estimated cost $1,500,000. W. E. Spink, Canal-Commercial Bldg., is associate architect.

Mass., Malden (Boston P. O.)—H. P. Hood & Son Inc., 194 Rutherford Ave., Charlestown, is having plans prepared for the construction of a refrigerating plant and office at 339 Washington St., here. Estimated cost $50,000. Private plans.

Mass., Roxbury (Boston P. O.)—Department of Institutions, Boston, is receiving bids for the construction of a 3 story addition to hospital on Parker Hill Ave., here. Estimated cost $1,600,000. O'Connell & Shaw, 134 Newbury St., Boston, are architects.

Mass., South Boston (Boston P. O.)—Gillette Safety Razor Co., 41 West First St., plans the construction of a boiler house. Estimated cost $40,000. C. T. Main, 200 Devonshire St., Boston, is architect.

Michigan—Public Service Engineering Co., 72 West Adams St., Chicago, Ill., awarded contract for the construction of two hydro electric plants on the Thornapple River, in Kent County, one at Ada to Price Bros. Co., Dayton, Ohio, and one at Cascade to R. E. Townsend Corp., Ann Arbor. $192,776 and $171,150 respectively. Water wheel equipment for both plants to S. Morgan Smith Co., P. O. Box 667, York, Pa. Electrical equipment complete to Westinghouse Electric & Mfg. Co.

Mo., Marionville—Marionville Cold Storage Co., is having plans prepared for the construction of a 4 story cold storage and refrigeration plant. Estimated cost $85,000. Heikenlway & Mark, 642 Landers Bldg., Springfield, are architects.

Mo., St. Louis—H. J. Rush, et al, 6038 Delmar Blvd., are having preliminary plans prepared for the construction of a 15 story hotel at Delmar and Des Peres Sts. Estimated cost $2,000,000. Rush-Lee-Rush, 6038 Delmar Blvd., are architects. Russell-Viterbo, Arcade Bldg., are engineers.

Mo., Springfield—Springfield Gas & Electric Co., A. E. Reynolds, Mgr., Landers Bldg., plans the installation of a 10,000 hp. steam turbine.

Neb., Lincoln—State Board of Control, E. B. Fairfield, Secy., plans improvements to power plant including equipment for state penitentiary. Estimated cost $100,000. Architect and engineer not selected.

Neb., Omaha—Liberty Film Co., 1514 Davenport St., has purchased site and plans the construction of a 6 story theatre and apartment at 20th and Dodge Sts. Estimated cost $1,500,000. Architect not selected.

N. J., Jersey City—Christ Hospital, 176 Palisade Ave., is having plans prepared for the construction of a 5 story hospital. Estimated cost $500,000. J. T. Rowland, 100 Sip Ave., is architect and engineer.

N. Y., Brooklyn—Montague Construction Corp., c/o H. C. Severance, 36 West 44th St., New York, Archt., is having plans prepared for the construction of a 35 story office building at Court and Montague Sts. Estimated cost $2,350,000.

N. Y., Mt. Vernon—Westchester Lighting Co., F. A. Stratton, Pres., South First Ave., plans the construction of an office building on First Ave. Estimated cost $1,000,000. Private plans.

N. Y., New York—Court Square Building, Inc., c/o Buckman & Kahn, 49 West 45th St., Archts., is having plans prepared for the construction of a 21 story office building at Reade and Elm Sts. Estimated cost $2,500,000.

N. Y., New York — New York State Psychiatric Institute & Hospital, 168th St. and Broadway, is having plans prepared for the construction of a hospital. Estimated cost $1,600,000. S. W. Jones, Capitol, Albany, is state architect.

N. Y., New York—Presbyterian Hospital, Madison Ave. and 78th St., plans the construction of a 14 story nurses' home at Riverside Drive between 166th and 167th Sts. Estimated cost $1,000,000. Architect not selected.

N. Y., Syracuse—M. H. Mark Theatrical Enterprises, Mark Strand Theatre, 1579 Broadway, New York, is having plans prepared for the construction of a theatre and office building, here. Estimated cost $1,500,000. T. W. Lamb, 644 8th Ave., New York, is architect and engineer.

O., Cincinnati—Hamilton County, plans the construction of a sanitary sewage system and pumping station including pumping equipment, at Beechwood and Edgemont sub-division. Estimated cost $108,204. L. C. Boyatt, Court House, is engineer.

O., Hamilton—American Hotels Corp., F. Vaughn, Pres., 25 West 45th St., New York, N. Y., plans the construction of a 10 story hotel here. Estimated cost $600,000. Architect not selected.

Okla., Collinsville—City is having preliminary plans prepared for improvements to waterworks including pumping equipment, mains, etc. Estimated cost $35,000. Holway Engineering Co., 505 New Wright Bldg., Tulsa, is engineer.

Okla., Davenport—City plans an election Jan. 6 to vote $25,000 bonds for improvements to waterworks including new deep well and pumps, also motor-driven centrifugal pump, etc. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Okla., Harrah—Oklahoma Gas & Electric Co., Insurance Bldg., had preliminary plans prepared for a new 27,000 hp. steam turbine generator set, 1,000 hp. boiler, condenser and auxiliaries for plant here. Estimated cost $1,000,000. Work will be done by owners' forces. Owner is in the market for equipment.

Okla., Sand Springs—C. Page, c/o Chamber of Commerce, plans the construction of a hydro-electric plant including a dam, 600 ft. long, 65 ft. high, spillway, 2,000 ft. long, 53 ft. high, three 5,000 k.w. turbines, etc. on the Illinois river. Estimated cost $2,000,000. Company engineers in charge.

Okla., Tulsa—Civic Headquarters Building Committee, c/o A. L. Farmer, Chn., will receive bids about Jan. 15 for the construction of a 10 story civic building. Estimated cost $500,000. Rush Endicott & Rush, New Wright Bldg., are architects.

Okla., Waynoka—Railway Ice Co., 309 South LaSalle St., Chicago, Ill., is having preliminary plans prepared for the construction of 100 ton addition to ice plant at Santa Fe yard here. Estimated cost $175,000. Engineer not announced.

Ore., Portland—Portland Hotel Co., Sixth and Morrison Sts., will soon receive bids for the construction of a hotel at Morrison, Yarnhill, Fifth and Sixth Sts. Estimated cost $1,000,000. C. Richardson, Lewiston, Idaho, is architect.

Pa., Fox Chase (Philadelphia P. O.)—Jeannes Memorial Hospital, c/o Heacock & Hokenson, 1211 Chestnut St., Philadelphia, Archts., will receive bids until Jan. 7 for the construction of a group of hospital buildings at Filmore, Shelmore, Hartel and Hasbrook Sts.

Tenn., Johnson City—American Bemberg Corp., awarded contract for the construction of a plant including power house, pump house, water supply system, etc. to Hughes-Foulkrod Co., Commonwealth Bldg., Philadelphia, Pa. Estimated cost $1,250,000.

Tenn., Memphis—C. F. Farnsworth, 1720 Central St., is having plans prepared for the construction of a 12 story office building including 3 elevators at South Main and Union Aves. Estimated cost $500,000. E. L. Harrison, Fidelity Bank Bldg., is architect.

Tex., Fort Worth—J. H. Jones, c/o W. C. Hedrick, 100 Ashland St., plans the construction of a 16 story office building at Lamar and West 7th Sts. Estimated cost $1,000,000. Architect not selected.

Tex., Galveston—International Cotton Refining Corp., P. C. Wadsworth, Pres., 42 Broadway, New York, N. Y., is having preliminary plans prepared for the construction of a cotton refining plant here. Estimated cost $100,000. Company engineers in charge. Electrically operated machinery will be purchased.

Tex., Nacogdoches—City plans an election soon to vote $45,000 bonds for improvements to waterworks including pumping equipment, etc., also $50,000 bonds for additional dynamos, engines, generators, etc., for light plant. W. I. Baker, City Hall, is mayor.

Wash., Seattle—Camlin Investment Co., awarded contract for the construction of an 11 story apartment including central heating plant at 9th and Pine Sts., to Western Construction Co., Seaboard Bldg. Estimated cost $500,000.

Wis., Gillett—Village, P. Nygaard, Clk., plans an election to vote bonds for the construction of waterworks and sewage systems including deep well, pumping station, reservoir, elevated tank, etc. McMahon & Clark, Menasha, are engineers.

Que., Verdun—Montreal Water Board, 259 Joseph St., will receive bids until Jan. 14 for a 1,900 hp. motor and starting equipment for 30 M.G.D. electric pump.